United States
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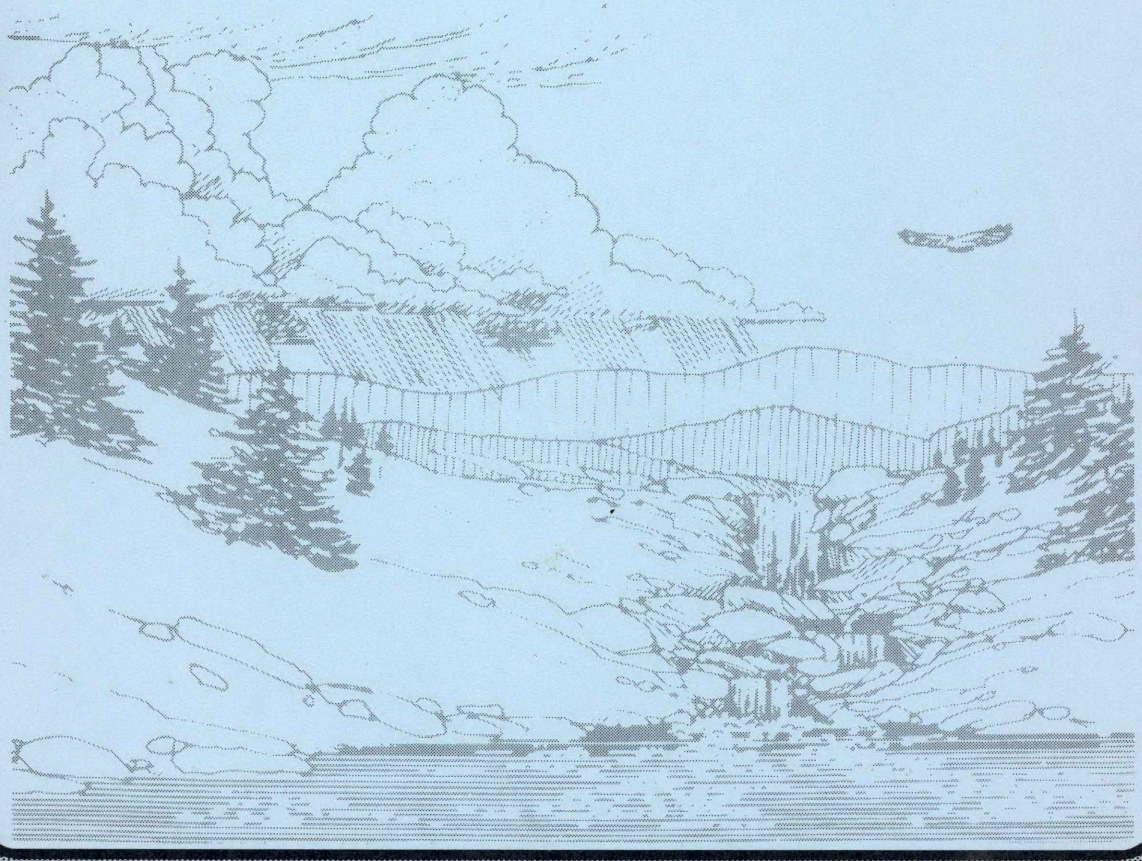
Forest Service

Northeastern
Forest
Experiment
Station

Research Attainment Report

Fiscal Year 1993



Abstract

This report contains information on research attainment during fiscal year 1993 at the Northeastern Forest Experiment Station of the USDA Forest Service. Data presented include the funding and staffing for each problem, a narrative summary of the attainment in each problem, and a bibliography of all publications resulting from this research.

KEYWORDS: Research, attainment, research management

Northeastern Forest Experiment Station 1993. Research Attainment Report: Fiscal Year 1993. Radnor,PA U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 181p.

Research Attainment Report Fiscal Year 1993

United States Department of Agriculture
Forest Service
Northeastern Forest Experiment Station

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Preface

This attainment report serves as one basis on which to evaluate USDA Forest Service research programs and work unit performance. It also provides information required by the Congress, the Department of Agriculture, and the Office of Management and Budget for their use in evaluating Forest Service research progress. This report for the Northeastern Forest Experiment Station will be aggregated with reports from other Forest Experiment stations to prepare a national report on research programs and accomplishments.

The basis for this report is the Research Work Unit Description (RWUD) for each work unit. The RWUD defines each unit's mission and problems to be studied to accomplish that mission. The approach to detailed investigation of each problem is described in a problem analysis. The problem analysis serves as a basis for preparing a series of study plans, each contributing to the problem solution, and ultimately, to accomplishment of the work unit mission.

Introduction

The Research Work Unit Attainment Reports in Part I each begin with a Research Work Unit Summary. This summary is in the form of a table, listing the problem number and title, the functional account funding the problem, the current level of funding, the current staffing (scientist years) and a tally of the number of publications produced, whether in the work unit, through extramural research, or through cooperative research.

The Research Work Unit Summary is followed by further information for each problem giving the attainments for a single problem. These reports give bibliographic information on each publication resulting from the research on a particular problem, plus a narrative summary of the attainment for that problem.

Part II is a bibliography of all the publications produced as a result of research conducted by the Northeastern Forest Experiment Station in Fiscal Year 1993, listed in alphabetical order by author under the proper functional account.

Part I: Research Work Unit Attainment Reports

Northeastern Forest Experiment Station
Forest Management Research
Research Work Unit 4101

Growth and Culture of Central Appalachian Hardwoods
Smith, H. Clay, Project Leader

FY 93 Research Attainments
Research Work Unit Summary

Problem number and title	Functional account	Current funding	Current staffing	Research Outputs		
				Research unit	Extra-mural	Cooper-ative
		thousand dollars	*scientist years*			
1. Silviculture management options which are ecologically sound and socially acceptable	FMR	366	1.0	1		1
2. Evaluating and comparing silvicultural practices to identify cost efficient management	FMR	219	1.0	2		
3. Guidelines for the establishment and development of desirable reproduction are not adequate	FMR	146	1.0	3		

Problem 1 **Silviculture management options which are ecologically sound and socially acceptable**
FY 93 Research Attainments

Publications

Research Unit

Miller, Gary W.; Smith, H. Clay. 1993. A practical alternative to single-tree selection. Northern Journal of Applied Forestry. 10 (1): 32-38.

Cooperative

Godwin, Marc Layne; Wood, Frederica; Adams, Mary Beth; Eye, Maxine C. 1993. Annotated bibliography of research related to the Fernow Experimental Forest. Gen. Tech. Rep. NE-174. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 131 p.

Attainment

Forest managers and landowners were provided with a practical alternative to the single-tree selection partial cutting practice. Often single-tree selection is suggested as the only advisable, long-term partial regeneration harvest method. Based on 20-year results, most of the objectives of a single-tree selection practice can be attained using guidelines for a flexible diameter-limit in combination with an improvement cut. Currently, there is considerable interest in non-clearcutting type regeneration practices. Partial cuts creating small openings in overstory crown canopy are becoming more acceptable and though esthetically pleasing, biological tradeoffs such as the reproduction of more shade-tolerant species occur. Demonstration areas are available and reviewed periodically by forest managers, landowners, and the public. Current information is used by the National Forest System, forest industries, state organizations, and educational programs. Information is disseminated through publications, training sessions, workshops, Northeastern Decision Model (NED), and individual requests.

Problem 2 **Evaluating and comparing silvicultural practices to identify cost efficient management**
FY 93 Research Attainments

Publications

Research Unit

Miller, Gary W. 1993. Financial aspects of partial cutting practices in central Appalachian hardwoods. Res. Pap. NE-673. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 9 p.

Miller, Gary W. 1993. Prescribing optimal harvests in forests containing even-aged and uneven-aged stands. Blacksburg, VA: Virginia Polytechnic Institute and State University. 111. Ph.D. dissertation.

Attainment

Interest in applying uneven-aged practices in eastern hardwood stands has grown in recent years. This interest is a response to public opposition of even-aged practices such as clearcutting. Where forest management goals require a more or less continuous cover of overstory trees to satisfy resource objectives, it is necessary to use partial cuttings. Forest managers and landowners have financial information to help them evaluate silvicultural alternatives and management opportunities and tradeoffs for a variety of partial cutting practices. Observed volume growth, product yields, changes in species composition, and changes in residual stand quality are used to evaluate potential financial returns. Financial information for other aspects of cutting practices such as logging damage, management of non-merchantable trees and improvement of diameter-limit cutting are also avaiable. Forest managers and landowners can more effectively isolate costs and benefits of partial silvicultural cutting practices, determine which practices are economical based on current information and utilize optimization guidelines for applying both even-aged and uneven-aged practices. Results have been published and used at workshops and training sessions by foresters associated with the management of public, industrial, and private land ownerships. Research information is disseminated via on-site visits, publications, videos, and the Northeast Decision Model.

Problem 3 **Guidelines for the establishment and development of desirable reproduction are not adequate**
FY 93 Research Attainments

Publications

Research Unit

Galford, Jimmy R.; Auchmoody, R. L.; Walters, Russell S.; Smith, H. Clay. 1992. Millipede damage to germinating acorns of northern red oak. Res. Pap. NE-667. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 4 p.

Schuler, Thomas M. 1993. Survival, growth, and target canker infection of black walnut families 15 years after establishment in West Virginia. Res. Pap. NE-674. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 8 p.

Smith, H. Clay. 1993. Development of red oak seedlings using plastic shelters on hardwood sites in West Virginia. Res. Pap. NE-672. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 7 p.

Attainment

Information is provided on the development of red oak seedlings on excellent growing sites using artificial regeneration techniques. Preliminary information indicates plastic shelters have the potential to significantly stimulate height growth, especially if height growth continues once the seedlings are above the 5-foot shelters. Acorns are subject to many insect pests including beetles, weevils, and moths. When these factors along with mammals are considered, the available seed source is drastically reduced. Millipedes were also identified as feeding on radicles of germinating red oak acorns. Fifteen-year information from black walnut plantations where 34 families were evaluated indicate northern families are more suited to the local conditions based on height and diameter growth. Periodic removal of individual trees has virtually eliminated most local seed sources. Successful reestablishment of black walnut in parts of this region has potential based on a local provenance study. This is true especially if the target canker, which kills trees, is controlled or if some families are more resistent than others to canker infection. All reported information relates to increasing the knowledge on factors influencing seedling establishment and development. Information is being used in prescribing guidelines by public, industrial, and private forest managers and landowners. Research outputs include publications, workshops, training sessions, videos, and individual consultation.

Northeastern Forest Experiment Station
Forest Management Research
Research Work Unit 4103

The Role of Environmental Stress on Tree Growth and Development

Tyree, Melvin T., Project Leader

FY 93 Research Attainments
Research Work Unit Summary

Problem number and title	Functional account	Current funding	Current staffing	Research Outputs: Research unit	Research Outputs: Extra-mural	Research Outputs: Cooperative
		thousand dollars	*scientist years*			
1. Better define and measure state of tree health in order to identify significant stress events	FMR	382	.6			
2. Understanding water-stress physiology: hydraulic sufficiency of stem to conduct water to leaves	FMR	263	2.0	4		3
3. Physiological changes associated with acidic leaching of leaf nutrients	FMR	277	1.5	1		
4. Knowledge of tree chemistry and physiology needed to understand effects of winter and acidic injury	FMR	66	1.0	1		2

Problem 1 **Better define and measure state of tree health in order to identify significant stress events**
FY 93 Research Attainments

Publications

none

Attainment

We are now in the fourth year of a five-year program. Annually collected soil, leaf, and stem samples have confirmed that the declining maples are nutrient poor in calcium (sometimes potassium & magnesium) also have a low soil pH. Response to fertilizer amendments on subplots is being monitored for the fourth year. Data analysis is complete for 3 publications and a Ph.D. student (Xuan Liu) is writing her results on physiological responses of sugar maple in healthy and declining sites. Two publications are anticipated on the effect of nutrient stress on photosynthesis and root growth. Work on interacting effects of drought and insect damage had to be discontinued because of reductions in project funding. To better understand and correlate the relationship between carbohydrate status and maple decline symptoms, the seasonal patterns of nonstructural carbohydrates from healthy sugar maple trees were determined using stem wood studies. The first paper on the pattern of starch, sucrose, glucose, and fructose during the leafless period is completed and being reviewed. Data analysis is complete for the second paper and samples collected for the third portion of this series is being prepared for analysis.

Problem 2

Understanding water-stress physiology: hydraulic sufficiency of stem to conduct water to leaves
FY 93 Research Attainments

Publications

Research Unit

Tyree, Melvin T. 1993. Theory of vessel-length determination: the problem of non-random vessel ends. Canadian Journal of Botany. 71: 297-302.

Tyree, Melvin T.; Alexander, John D. 1993. Hydraulic conductivity of branch junctions in three temperate tree species. Trees. 7: 156-159.

Tyree, Melvin T.; Alexander, John D. 1993. Plant and water relations and the effect of elevated CO2: a review and suggestions for future research. Vegetatio. 104: 47-62.

(Article published in journal volume and book format, both by the same publisher)

Tyree, Melvin T.; Yang, Shudong. 1992. Hydraulic conductivity recovery versus water pressure in xylem of Acer saccharum. Plant Physiology. 100: 669-676.

Cooperative

Cochard, Herve'; Cruiziat, Pierre; Tyree, Melvin T. 1992. Use of positive pressures to establish vulnerability curves: Further support for the air-seeding hypothesis and implications for pressure volume analysis. Plant Physiology. 100: 205-209.

Johnson, Robert W.; Tyree, Melvin T. 1992. Effect of stem water content on sap flow from dormant maple and butternut stems. Plant Physiology. 100: 853-858.

Yang, Shudong; Tyree, Melvin T. 1993. Hydraulic resistance in Acer saccharum shoots and its influence on leaf water potential and transpiration. Tree Physiology. 12: 231-242.

Attainment

A new method has been developed to measure the hydraulic architecture of trees. A high pressure flow meter is used to measure the rate of flow of water into the base of an excised shoot. The applied pressure divided by the flow rate gives shoot resistance to water flow. This method has been used to evaluate resistance to water flow in leaves, petiols, and stems of four species of oak, to evaluate why walnut sheds leaves during drought, and to measure root resistance to water flow. Of the three papers drafted on this work, two are in press. Three other papers on water relations of tropical trees have been drafted and submitted.

Balsam fir growing on low-elevation and high-elevation sites have different anotomical and morphological characteristics. The hydraulic conductivity of mainstem and branch segments of trees from the two populations has been determined. This work focused on determining weather the hydraulic architecture of the trees will lead to an understanding on the anotomically and physiolology based mechanisms that define the high-elevation trees as an ecotype. Data analyses and manuscript preparation are in progress.

Architecture of the trees will lead to an understanding of the anatomically-based and physiologically-based mechanisms that define the high-elevation trees as an ecotype. Data analysis and manuscript preparation is in progress.

Problem 3 **Physiological changes associated with acidic leaching of leaf nutrients**
FY 93 Research Attainments

Publications

Research Unit

Tyree, Melvin T.; Wescott, Charles R.; Tabor, Christopher A.; Morse, Anne D. 1992. Diffusion and electric mobility of KCI within isolated cuticles of citrus aurantium. Plant Physiology. 99: 1057-1061.

Attainment

The objective of this year's research has been to develop new techniques of data collection. Electronics have been redesigned and rebuilt for measuring ion permeation across isolated cuticles. Software has also be written to acquire data via computer. Preliminary studies have shown that the new system allows measurement of much smaller ionic permeation rates and increases accuracy. This system will be used to measure the effect of pH on ion leaching from leaves.

A study to determine the effect of different levels of metals and acidity on mycorrhizal and nonmycorrhizal pine seedlings will result in two publications. Data analysis is in progress on another publication concerning the root and needle mitochondrial response to metal and acidity stresses.

Problem 4 Knowledge of tree chemistry and physiology needed to understand effects of winter and acidic injury

FY 93 Research Attainments

Publications

Research Unit

Wilkinson, R. C.; Schaberg, P.G. 1993. Balsam twig aphid damage on balsam fir from six Vermont seed sources. Poster presented at the 10th annual Vermont forest pest workshop; 1993 January 11; Burlington, VT.

(No documentation included)

Cooperative

Cumming, J. R.; DeHayes, D. H.; Hawley, G. J.; Strimbeck, R.; Wilkinson, R. C. 1993. The possible role of pollution-induced calcium perturbations in freezing injury of red spruce. In: The effects of air pollution on terrestrial and aquatic ecosystems in New England and New York; 1992, October 19-21; Waterville Valley, NH. [Place of publ. unknown]: [Publisher name unknown]: 21.

Thornton, F. C.; McDuffie, C., Jr.; Pier, P. A.; Wilkinson, R. C. 1993. The effects of removing cloudwater and lowering ambiant O3 on red spruce grown at high elevations in the southern Appalachians. Environmental Pollution. 79: 21-29.

Attainment

Initial field evaluations of winter physiology of red spruce (which is regularly injured in winter) and balsam fir (which is rarely injured) have produced several interesting results. It was found that under certain environmental conditions (especially prolonged thaws), both red spruce and balsam fir can have positive net photosynthesis (i.e. they are not always "dormant" during winter). Red spruce also has significantly greater net photosynthesis during winter than balsam fir does, and this information may explain the causes and differences in winter injury susceptability between these two conifers. However, differences in weather conditions between field seasons have made it difficult to fully characterize the extent and significance of winter physiological activity. During the past winter season, environmental and physiological monitoring has been expanded to better assess the nature and importance of winter tree activity. Assessments of genetic influences on amounts of epicuticular wax on needles and transpirational water losses have been made on trees from a range-wide provenance test. A cooperative agreement with the University of Vermont has been implemented to help develop a physiological understanding of the mechanism(s) responsible for reduction in cold tolerance of red spruce after exposure to acidic cloud water.

Northeastern Forest Experiment Station
Forest Management Research
Research Work Unit 4104

Methods for Measurement, Analysis, and Modeling of Forest Growth and Structure

Solomon, Dale S., Project Leader

FY 93 Research Attainments
Research Work Unit Summary

Problem number and title	Functional account	Current funding	Current staffing	Research Outputs: Research unit	Research Outputs: Extra-mural	Research Outputs: Cooperative
		thousand dollars	*scientist years*			
1. Traditional methods are inadequate for modeling effects of environmental changes on forest trees	FMR	163	1.5	3		2
2. Present growth predictions inadequate and lack mgmt. strategies, responsive to envir. changes	FMR	163	1.5	4		1

Problem 1 **Traditional methods are inadequate for modeling effects of environmental changes on forest trees**
FY 93 Research Attainments

Publications

Research Unit

Gove, Jeffery H. 1993. Geostatistical modeling of tree crown shapes. In: IUFRO S4.11 International conference stochastic spatial models in forestry; 1993 May 18-21; Thessaloniki, Greece. Thessaloniki, Greece: Aristotle University of Thessaloniki: 1 p.

Valentine, Harry T.; Gregoire, Timothy G.; Furnival, George M. 1992. Estimation of the aggregate bole volume of a population of trees by stratified, two-stage, probability sampling. The Statistician. 41: 499-507.

Valentine, Harry T.; Gregoire, Timothy G.; Furnival, George M. 1993. Estimation of the aggregate bole volume of a forest by stratified, two-stage, probability sampling. In: Rennolls, Keith; Gertner, George, eds. Proceedings, IUFRO conference: The optimal design of forest experiments and forest surveys; 1991 September 10-14; London, England. London, England: The University of Greenwich: 249-257.

Cooperative

Gregoire, T.G.; Valentine, H.T.; Furnival, G.M. 1993. Estimation of bole surface area and bark volume with Monte Carlo methods. Biometrics. 49: 653-660.

Gregoire, Timothy G.; Valentine, Harry T.; Furnival, George M. 1993. Two-stage and three-stage sampling strategies to estimate aggregate bole volume in the forest. In: Nyyssonen, Aarne; Poso, Simo; Rautala, Johanna, eds. Proceedings of Ilvessalo symposium on national forest inventories; 1992 August 17-21; Helsinki, Finland. Res. Pap. 444. Helsinki, Finland: Finnish Forest Research Institute; 444: 201-213.

Attainment

A carbon-balance pipe model of stand growth for loblolly pine has been developed in connection with a cooperative agreement between the Virginia Polytechnic Institute and the southern global change program. Current objectives for further development are to include the effects of temperature and moisture in the parameterization of key physiological rates and to analyze the sensitivity of growth projections of the model to climatic variation. In the past year, data to permit the evaluation of parameters in SPM1 were collected, analyses of these data were initiated, and analyses of previous data were continued; SPM1 was enhanced and recorded, and it was demonstrated before various groups in the U.S. and Canada. Equations were developed that estimate foliar dry matter from measures of tree diameter and crown ration: regional climate data have been organized and reduced into meaningful monthly values. In addition, a stratified, randomized branch sampling design for the purpose of estimating foliar dry matter and average stem length was field tested and implemented.

Problem 2 **Present growth predictions inadequate and lack mgmt. strategies, responsive to envir. changes**
FY 93 Research Attainments

Publications

Research Unit

Gove, Jeffrey H.; Martin, C. Wayne; Patil, Ganapati P.; Solomon, Dale S.; Hornbeck, James W. 1992. Plant species diversity on even-aged harvests at the Hubbard Brook Experimental Forest: 10-year results. Canadian Journal of Forest Research. 22 (11): 1800-1806.

Solomon, Dale S.; Hosmer, Richard A. 1989. SIMSAP/SIMTIM: Stand projection model for northern hardwoods. In: Briggs, Russell D.; Krohn, William B.; Trial, Joan G.; Ostrofsky, William D.; Field, David B., eds. Proceedings of a joint meeting of the Maine Division of New England Society of American Foresters, Maine Chapter of the Wildlife Society, and the Atlantic International Chapter of the American Fisheries Society; 1989 March 15-17; Portland, ME. SAF Publ. 89-05. Portland, ME: Maine Agricultural Experiment Station: 336. Abstract.

Solomon, Dale S.; Brann, Thomas B. 1992. Ten-year impact of spruce budworm on spruce-fir forests of Maine. Gen. Tech. Rep. NE-165. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 44 p.

Solomon, Dale S.; Holmes, Michael J.; Leak, William B. 1992. Measured and predicted growth rates in mixed-species northern hardwood stands in the northeastern United States. In: IUFRO S4.01 Mensuration, growth and yield; 1992 August 31- September 4; Berlin, Germany. Freising, Germany: Hanskarl Goettling Stiftung: 153-161.

Cooperative

Gove, Jeffery H. 1992. Inventory and diversity programs from the NEFES. The Compiler. 10(2): 21 Abstract.

Attainment

Analytical methods are developed for determining and comparing plant species diversity between two different communities. The procedure utilizes a statistical technique called the non-parametric jackknife and diversity profiles. It has been applied to watersheds on the Hubbard Brook Experimental Forest, NH to compare plant community diversity within watersheds over time as the communities respond to cutting, and to compare the changes on different watersheds at a given point in time.

Programs are under development at the Durham, NH laboratory for analyzing forest inventory data and diversity measurements. The forest inventory program, PCInvent, is completed and available for distribution on IBM compatible personal computers.

Geostatistical methods are developed and applied to the spatial statistical estimation problem of modeling tree crown shape. Variography is used in the analysis of the spatial continuity of a tree crown in detail. The variograms estimated from hypothetical tree crowns were used to estimate crown shape by ordinary kriging.

Twenty-five years of growth in a northern hardwood stand treated to four levels of stand density and three levels of percent sawtimber were compared to predictions by the models NETWIGS and FIBER. Projections tended to be low due to an underestimation of increased ingrowth occurring 10-15 years following heavy reduction in basal area. This difficulty can be addressed by incorporating a system that will better reflect growth patterns.

Northeastern Forest Experiment Station
Forest Management Research
Research Work Unit 4151

Ecology and Management of Northern Conifer and Associated Ecosystems
Brissette, John C., Project Leader

FY 93 Research Attainments
Research Work Unit Summary

Problem number and title	Functional account	Current funding	Current staffing	Research Outputs		
				Research unit	Extra-mural	Cooper-ative
		thousand dollars	*scientist years*			
1. Long-term effects of silvicultural options on habitat diversity, stand structure, and yields	FMR	384	1.8	1		
2. Developing information about the ecophysiology of northern conifer seedling establishment	FMR	4	.2			

Problem 1 **Long-term effects of silvicultural options on habitat diversity, stand structure, and yields**
FY 93 Research Attainments

Publications

Research Unit

Frank, Robert M. 1993. Tree and wildlife diversity responses to silvicultural practices in northern conifers. In: Simpson, C.M., comp. Proceedings of the seminar on integrated resource management; 1992 April 7-8; Fredericton, NB. Federicton, NB: Forestry Canada - Maritimes Region: 57-75.

Attainment

An examination of the effects of ten silvicultural treatments, after 30-35 years of observations, on the diversity of tree species and on the expected use of these treated areas by eight species of wildlife culminates several years of progress in tree/wildlife interrelationships as part of the compartment management studies project of the unit. These results were published as part of a Canadian seminar on integrated resource management. Preliminary results from a precommercial spacing (thinning) study after 15.5 years of response show a post-spacing periodic annual merchantable volume increment of 45.1 cu.ft. per acre. Mean annual increment in the same 30-year old stand is 23.3 cu. ft. per acre. Estimates for total volumes increase these yields by approximately 36 percent and 41 percent respectively. Field work is part of the continuing long-term silvicultural efforts on the Penobscot Experimental Forest consisted of nine of nine inventories and five harvest operations on both compartments and research management units. Approximately 425 visitors in a wide variety of 18 groups were hosted by Unit personnel on the Penobscot Experimental Forest. These groups represented 6 Federal/Provincial/State agencies, 4 colleges and schools, 3 conservationist organizations, and 6 tours involving professional associations. Additionally, two programs were presented on problem findings. One program was a shelterwood lecture and the other was a 2-day short course on the selection system.

Problem 2 — Developing information about the ecophysiology of northern conifer seedling establishment
FY 93 Research Attainments

Publications

none

Attainment

Progress on this problem includes preparation for controlled laboratory and greenhouse experiments to determine relationships between water uptake by the roots and water relations of the shoot for a range of environmental conditions. These relationships will be applied to field experiments designed to investigate the interactive effects of environmental factors such as light, soil water availability and temperature on seedling establishment.

Northeastern Forest Experiment Station
Forest Management Research
Research Work Unit 4152

Silvicultural Decision Systems for Eastern Hardwood Forests of the Mid-Atlantic Region
Stout, Susan L., Project Leader

FY 93 Research Attainments
Research Work Unit Summary

Problem number and title	Functional account	Current funding	Current staffing	Research Outputs: Research unit	Research Outputs: Extra-mural	Research Outputs: Cooperative
		thousand dollars	*scientist years*			
1. How to control species composition during regeneration for a variety of objectives	FMR	558	3.5	9		1
2. Regulate stand growth and development to maximize multiple-use benefits from existing stands	FMR	93	.4			1
3. Effects of silvicultural practices on wildlife habitat, aesthetics, and on diversity	FMR	293	1.0			1
4. Consolidate the vast array of multiple resource knowledge into a computer-based decision tool	FMR	52	.1	1		

Problem 1 **How to control species composition during regeneration for a variety of objectives**
FY 93 Research Attainments

Publications

Research Unit

Auchmoody, L.R. 1992. Biotic limitations to red oak regeneration. In: Hedge, Cloyce, ed. Proceedings, 19th annual natural areas conference; 1992 October 27-30; Bloomington, IN. Bloomington, IN: Indiana University: 3. Abstract.

Auchmoody, L.R.; Walters, Russell S. 1993. Impact of deer browsing, overstory density, and competition on survival and development of planted northern red oak seedlings. In: Thompson, Janette R.; Schultz, Richard C.; Van Sambeek, J.W., eds. 5th workshop on seedling physiology and growth problems in oak plantings; 1992 March 4-5; Ames, IA. Gen. Tech. Rep. NC-158. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station: 1. Abstract.

Horsley, Stephen B. 1993. Morphological and physiological responses of black cherry and yellow birch to understory shade light in Prunus-Acer Allegheny hardwood stands in Pennsylvania, USA. In: Ecophysiology and genetics of trees and forests in a changing environment; 1993 May 23-30; Viterbo, Italy. [Place of publ. unknown]: International Union of Forestry Research Organizations: 175-176.

Horsley, Stephen B.; Gottschalk, Kurt W. 1993. Leaf area and net photosynthesis during development of Prunus serotina seedlings. Tree Physiology. 12: 55-69.

Horsley, Stephen B. 1992. Historical and contemporary herbivory by deer in a temperate forest ecosystem: the Allegheny hardwood forest. Bulletin of the Ecological Society of America. 73(2) Suppl. [212] Abstract.

Horsley, Stephen B. 1993. How deer browsing creates vegetation management problems in Allegheny hardwood forests. In: Bellinder, R.R., ed. Proceedings, 47th annual meeting of the Northeastern Weed Science Society; 1993 January 4-7; Baltimore, MD. Ithaca, NY: Northeastern Weed Science Society: 84. Abstract.

Marquis, David A. 1993. Silviculture as an alternative in deer management. In: Deer management in an urbanizing region: problems and alternatives to traditional management: Proceedings of the conference. Donald, Rhonda Lucas, ed.; 1988 April 13; East Windsor, NJ. GR3184. Washington, DC: The Humane Society of the United States: 38-45.

Walters, Russell S.; Nowak, Christopher A. 1993. Understory vegetation changes on the Tionesta Scenic and Natural Areas: 1942-1992. In: Conservation in working landscapes: 20th annual natural areas conference; 1993 June 22-26 Orono, ME: University of Maine. [Place of publication unknown]: [Publisher name unknown].

Walters, Russell S. 1993. Protecting northern red oak seedlings with tree shelters. In: Thompson, Janette R.; Schultz, Richard C.; Van Sambreck, J.W., eds. 5th workshop on seedling physiology and growth problems in oak plantings; 1992 March 4-5; Ames, IA. Gen. Tech. Rep. NC-158. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station: 3. Abstract.

Cooperative

Sahm, James M.; White, Edwin H.; Nowak, Christopher A. 1993. Wood ash: its alternative uses and effects on forest soils. Waste Management Research Report. 5 (1): 2-7.

Attainment

Considerable progress has been made in identifying the extent of forest regeneration problems in Pennsylvania, the interaction of deer density with regeneration species composition and the critical factors preventing oak regeneration. A survey uncovered the fact that deer browsing is a major factor imapacting forest understory conditions. Results of a 10-year deer density study showed that deer density is the most important factor controlling the species composition of vegetation in the Allegheny hardwood forest type. The study showed that when high deer densities are maintained over a long period of time, palatable species (including many commercially important trees) are eaten and unpalatable species (including ferns, grasses and sedges) increase in abundance. Recently reported studies show that fern interference with desirable black cherry regeneration occurs through a fern shade-light mediated mechanism. Fern shade-light does not interfere with yellow birch regeneration. Thus, deer density facilitates the expansion of fern which interfere with black cherry regeneration, but allow birch to regenerate. Few demonstrations of the mechanisms through which herbivory operates are available in the world literature. Also important is the illucidation of the critical factors limiting oak regeneration in Pennsylvania. In addition to deer, small mammals and competing vegetation, insects play a significant, previously unrecognized role in acorn depredation. Results of these studies have been incorporated into the recommendations given professional foresters in the unit's training sessions and have been presented to audiences at professional society meetings.

Problem 2 **Regulate stand growth and development to maximize multiple-use benefits from existing stands**
FY 93 Research Attainments

Publications

Cooperative

Hillebrand, James J.; Earnst, Richard L.; Stout, Susan L.; Fairweather, Stephen E. 1992. Using relative diameter to improve density measures in Allegheny hardwood stands. Forest Ecology and Management. 55: 225-232.

Attainment

Relative measurements of density in even-aged stands of mixed hardwoods have proven more useful for assessing crowding than absolute measures. Species composition and average tree size often result in wide variation in absolute measures of trees per acre or basal area per acre. The measure currently used for Allegheny hardwood stands assesses relative density by summing the growing space of all trees as a function of their species and diameter. The relative density calculated by this measure is well correlated with net basal-area growth in unthinned stands and stands that have been silviculturally thinned, predominatly from below. The correlation with net basal-area growth is poor in stands that have been thinned to alter the stand structure. Several measures of density have been tested that are as highly correlated with net stand growth as a current measure in stands that have been silviculturally thinned. The new measures are more highly correlated with net stand growth in stands that have been thinned to alter stand structure. Improved density measures will prove useful to public and private land managers seeking to widen the range of silvicultural alternatives available for ecosystem management.

Problem 3 **Effects of silvicultural practices on wildlife habitat, aesthetics, and on diversity**
FY 93 Research Attainments

Publications

Cooperative

Witmer, Gary W.; deCalesta, David S. 1993. The need and difficulty of bringing the Pennsylvania deer herd under control. In: Curtis, Paul D.; Fargione, Michael J,; Caslick, James E., eds. Proceedings: 5th eastern wildlife damage control conference; 1991 October 6-9; Ithaca, NY. Ithaca, NY: Cornell Cooperative Extension, Cornell University: 130-137.

Attainment

Research done in the unit and elsewhere documents the important impact of deer overpopulation on wildlife habitat and diversity. Development of policy choices for this serious resource management alternative requires comprehensive understanding of the history of the interactions between human beings and the white-tailed deer (Odocoileus virginianus) in Pennsylvania. Vehicle-deer accidents, the incidence of Lyme disease, reductions in forest ecosystem diversity, economic losses to agriculture and forestry, and both economic and nuisance impact on browsing on landscaping efforts by homeowners and recreation site managers all create a necessity for deer herd management. A review of the history of such management suggests that the herd is currently stable at levels well above biological and cultural carrying capacity. Achieving target densities will require novel approaches to regulation of hunting in Pennsylvania. Such approaches might include increasing bag limits, conducting the antlerless deer hunt during the antlered deer hunt, more flexible responses to crisis deer browsing problems, especially on agricultural and forest lands, and a change to ecological, rather than political management units. Research reported this year provides support for policy changes to reduce deer overpopulation in Pennsylvania.

Problem 4 **Consolidate the vast array of multiple resource knowledge into a computer-based decision tool**
FY 93 Research Attainments

Publications

Research Unit

Marquis, David A.; Stout, Susan L. 1992. Multiresource silvicultural decision model for forests of the northeastern United States. In: Murphy, Dennis, comp. Getting to the future through silviculture- Workshop proceedings; 1991 May 6-9; Cedar City, UT. Gen. Tech. Rep. INT-291. Odgen, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station: 54-61.

Attainment

Work is underway in many Northeastern units to build the Northeast Decision Model, a decision support tool for ecosystem management on public and private lands in northeastern United States. The framework for decision making will be a match between a set of multiple resource goals and one or more silvicultural systems applied to a management unit, or group of stands with the same set of management goals. As the model development teams make progress on integrating existing research results, research needs are highlighted. The model will be used by public and private forest managers throughout the northeastern United States, and their input is helping to design the model.

Northeastern Forest Experiment Station
Forest Management Research
Research Work Unit 4153

Quantitative Methods for Modeling Ecosystem Response
Scott, Charles T., Project Leader

FY 93 Research Attainments
Research Work Unit Summary

Problem number and title	Functional account	Current funding	Current staffing	Research Outputs		
				Research unit	Extra-mural	Cooper-ative
		thousand dollars	*scientist years*			
1. Integrating models of plant processes with forest and landscape processes	FMR	55	.6			
2. Modeling of oak plant community responses to natural stressors and ecosystem management	FMR	247	1.7	1		
3. Developing ecosystem management practices for aesthetics, biodiversity, habitat and timber	FMR	194	1.6	1		
4. Monitoring subtle responses of forest ecosystems to global climate change and other stressors.	FMR	33	.5	4		2

Problem 1 **Integrating models of plant processes with forest and landscape processes**
FY 93 Research Attainments

Publications

none

Attainment

The conceptual model of ecosystem processes was presented at two meetings: "Regional and National Models for Global Change" and "US Landscape Ecology Symposium". The model was developed in collaboration with scientists from many disciplines and reflects the influence of atmospheric (climatic) and humans on trees, communities, landscapes, and biomes. It is structured as a series of interacting process models, with sets of state variables, processes, and outputs at five scales that increase in space and time. Components of the individual models are limited to the critical variables and processes that are necessary to adequately describe the system for use by the Global Change Program and for ecosystem management purposes. Presently, specific variables and their units are being described so that variables can be passed between scales, and so that models at different scales can interface. This model will facilitate the coordination of modeling efforts both within and outside of the Forest Service.

Problem 2 **Modeling of oak plant community responses to natural stressors and ecosystem management**
FY 93 Research Attainments

Publications

Research Unit

Sutherland, Elaine Kennedy; Yaussy, Daniel A., Dale, Martin E. 1993. Drought and differential mortality in southern Ohio mixed-oak forests. Bulletin of the Ecological Society of America. 74(2) (Suppl.): 451. Abstract.

Attainment

Precipitation and drought patterns are likely to be a significant part of global climate change. A study was conducted relating the effects of drought on the mortality of tree species in the Ohio River Valley (oak-hickory forests). Results show that the mortality rate doubled in response to droughts. Yellow-poplar and understory species (dogwood and sourwood) were especially vulnerable to droughts while oak and maple species were drought tolerant. This has implications for species composition in a changed climate. In a related study, the effects of drought on burned area in the Ohio River Valley was investigated. The Southern Oscillation Index (El Nino) and Palmer's Drought Severity Index were strongly related to the area burned in forest fires. Since there is a delayed reaction, area burned can be predicted up to six months in advance. This has both immediate application in fire management and potential application to ecosystem processes in an altered climate. A study of the factors (including climate) affecting stand establishment and recruitment was initiated. Species will be aggregated into groups which have similar regeneration patterns. The resulting models of seedling/sprout establishment will be input into mechanistic tree growth and development models to predict the life cycles for all major species groups in the United States. Simulation results of these models under various climatic scenarios will be scaled up to landscape simulations of species migration. The result will be regional and national predictions of potential tree species composition and ranges.

Problem 3 **Developing ecosystem management practices for aesthetics, biodiversity, habitat and timber**
FY 93 Research Attainments

Publications

Research Unit

Yaussy, Daniel A. 1993. Method for estimating potential tree-grade distributions for northeastern forest species. Res. Pap. NE-670. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 12 p.

Attainment

Fire has been actively suppressed in the eastern United States since the 1940's. Consequently, fire-dependent plant communities are degenerating. A study was conducted to construct the fire history of Table Mountain pine communities in West Virginia. Tree-ring analysis revealed that fires were common throughout 1798-1944 with a cycle of 9 to 11 years. No Table Mountain pine has regenerated since then indicating its strong fire dependence. Continued fire suppression is likely to extirpate this and other fire-dependant communities. Another study was initiated to assess the potential species composition in the forests of Ohio. Fire suppression may also play a role in the decline of the oak-hickory forests. Initial indications are that oak-hickory forests on good sites are shifting to more mesic species, such as yellow-poplar, red maple, ash, aspen, and black cherry. Poor (dry) sites return to oak and hickory but in mixture with other species, predominantly red maple. We plan to expand the results to all forest types in the state using the results from the recent survey conducted by Forest Inventory and Analysis.

Problem 4 — Monitoring subtle responses of forest ecosystems to global climate change and other stressors.

FY 93 Research Attainments

Publications

Research Unit

Scott, Charles T. 1993. Optimal design of a plot cluster for monitoring. In: Rennolls, K.; Gertner, G., eds. The optimal design of forest experiments and forest surveys: Proceedings of a IUFRO conference; 1991 September 10-14; London, UK. London, UK: University of Greenwich: 233-242.

Scott, Charles T.; Cassell, David L.; Hazard, John W. 1993. Sampling design of the U.S. national forest health monitoring program. In: Nyyssonen, A.; Poso, S.; Rautala, J., eds. Proceedings of the Ilvessalo symposium on national forest inventories; 1992 August 17-21; Helsinki, Finland. Res. Pap. 444. Helsinki, Finland: Finnish Forest Research Institute: 150-157.

Scott, Charles T.; Koehl, Michael. 1993. A method for comparing sampling design alternatives for extensive inventories. Mitteilungen der Eidgenossischen Forschungsanstalt fur Wald, Schnee und Landschaft. 68 (1): 3-62.

Scott, Charles T.; Koehl, Michael. 1993. Experiences with designing the forest survey of the northeastern United States. In: Kohl, Michael; Gertner, George Z., eds., Statistical methods, mathematics and computers: Proceedings, IUFRO S4.11; 1992 August 30-September 4; Berlin/Eberswalde, Germany. Birmensdorf, Switzerland: Swiss Federal Institute for Forest, Snow and Landscape Research: 139-148.

Cooperative

Roesch, Francis A., Jr.; Green, Edwin J.; Scott, Charles T. 1993. A test of alternative estimators for volume at time 1 from remeasured point samples. Canadian Journal of Forest Research. 23 (4): 598-604.

Schreuder, H.T.; Li, J.; Scott, C.T. 1993. Estimation with different stratification at two occasions. Forest Science. 39 (2): 368-382.

Attainment

Forest resource monitoring is needed for a variety of purposes at a variety of spatial scales. The National Forest Health Monitoring Program uses an extensive network of plot clusters to detect unanticipated changes in the forest resource. In collaboration with others, we reported on methods to unbiasedly estimate both area by condition and tree characteristics when clusters straddle condition boundaries. The Forest Health Monitoring Program collects the field data on a portable data recorder using a program which we developed and maintain. In collaboration with the Swiss government, a complete set of estimators were developed for sampling with partial replacement for two or three occasions with or without stratification. These methods can be used to compare various monitoring sampling designs using a computer program called SIZE. In a related study, a paper was presented in Copenhagen comparing permanent sample plots from forest surveys with experimental plots for use in developing growth models. In order to have models which adequately reflect the entire population and to make projections of forest surveys, the use of both kinds of plots was recommended for model development. Finally, the use of cluster samples is common in extensive surveys and monitoring designs, but incorrect estimation methods are often applied, such as in the German National Survey.

Northeastern Forest Experiment Station
Forest Management Research
Research Work Unit 4154

Ecology and Management of Beech-Birch-Maple Types in the Northeast
Garrett, Peter W., Project Leader

FY 93 Research Attainments
Research Work Unit Summary

Problem number and title	Functional account	Current funding	Current staffing	Research Outputs		
				Research unit	Extra-mural	Cooper-ative
		thousand dollars	*scientist years*			
1. Understand and document the structure and dynamics of northern hardwood ecosystems	FMR	232	2.4	5	2	
2. Better understand the ecological relationships between wildlife habitat and forest management	FMR	232	1.2	4		
3. Need to preserve undisturbed areas to study natural succession and impacts of global change	FMR	87	.8	3	3	
4. Need to preserve integrity of older plantations to document responses to environmental change	FMR	29	.6	1		
M5. A lack of mass production techniques prevents large-scale planting of pitch/loblolly pine hyb.	FMR	0	.1			

Problem 1 **Understand and document the structure and dynamics of northern hardwood ecosystems**
FY 93 Research Attainments

Publications

Research Unit

DeGraaf, R.M.; Yamasaki, M; Leak, W.B.; Lanier, J.W. New England wildlife - management of forested habitats. [slide/tape]. Durham, NH: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1993. 17 min.

Harris, M.M.; Safford, L.O. 1992. A rapid technique for drying organic soil horizons using a microwave oven. Soil Science. 154 (5): 420-425.

Smith, Marie Louise; Hallett, Rich. 1993. Regional ecological analysis using RDBMS and GIS technology: an example from Northern New England. In: 2nd international conference/workshop on integrating GIS and environmental modeling; 1993 September 26-30; Breckenridge, CO. [Place of publication unknown]: [Publisher name unknown]. Poster.

Smith, Marie-Louise. 1992. Habitat type classification and analysis of upland northern hardwood forest communities on the Middlebury and Rochester Ranger Districts, Green Mountain National Forest, Vermont. In: Proceedings national workshop: taking an ecological approach to management; 1992 April 27-30; Salt Lake City, UT. WO-WSA-3. Washington, DC: U.S. Department of Agriculture, Forest Service: 161. Abstract.

Solomon, Dale S.; Holmes, Michael J.; Leak, William B. 1992. Measured and predicted growth rates in mixed-species northern hardwood stands in the Northeastern United States. In: Preschuler, Tega, ed. Research on growth and yield with emphasis on mixed stands: Proceedings, IUFRO centennial meeting; 1992 August 31-Spetember 4; Berlin/Eberswalde, Germany. Berlin, Germany: International Union Forestry Research Organization: 153-161.

Extramural

Ellis, D.; Klein, A.S. 1992. Using RAPD markers to detect genetic diversity in tree populations: how to distinguish host variation from parasitic contamination. In: Mollecular biology [genetics] of forest trees: 5th workshop, IUFRO working party S2.04.06, Molecular Genetics; 1992 June 15-18; Carcans - Maubuisson, France. [Place of publication unknown]: International Union of Forestry Research Organization: p10. Abstract.

Klein, A.S.; Bobola, M.S.; Stapelfeldt, K.; Hillenberg, K.; Gendreau, S.; Eckert, R.T. 1992. Genetic variation and introgression between Picea rubens and P. mariana in natural populations. In: Molecular biology [genetics] of forest trees: 5th workshop, IUFRO working party. S2.04.06, Molecular Genetics and Cytogenetics; 1992 June 15-18; Carcans - Maubuisson, France. [Place of publication unknown]: International Union of Forestry Research Organization: 5.5. Abstract.

Attainment

Completed the remeasurment of 500 permanent plots on the experimental forests in New Hampshire and entered data from 1930's, 1960's and 1990's on computer software.

Habitat type classification research indicated that multi-factor ecological approaches to land classification are valid and demonstrated that similar approaches could be useful in stratification of landscapes into ecologically meaningful units. This approach was used to delineate boundaries for the Northeastern United States.

Problem 2 **Better understand the ecological relationships between wildlife habitat and forest management**
FY 93 Research Attainments

Publications

Research Unit

DeGraaf, Richard M.; Yamasaki, Mariko. 1992. A nondestructive technique to monitor the relative abundance of terrestrial salamanders. Wildlife Society Bulletin. 20 (3): 260-264.

DeGraaf, Richard M.; Yamasaki, Mariko; Leak, William B. 1993. Management of New England hardwoods, spruce fir types, and eastern white pine for neotropical migratory birds. In: Finch, D.M.; Stangel, P.W., eds. Status and management of neotropical migratory birds; 1992 September 21-25; Estes Park, CO. Gen. Tech. Rep. RM-229. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 363-373.

Leak, William B. 1991. Secondary forest succession in New Hampshire, USA. Forest Ecology and Management. 43: 69-86.

Yamasaki, Mariko. 1992. Marine turtles of the gulf of Maine. In: Hunter, Malcolm L., Jr.; Albright, John; Arbuckle, Jane, comps., eds. The amphibians and reptiles of Maine. Bull. 838. Orono, ME: University of Maine, Maine Agricultural Experiment Station: 120-124.

(Part of the Maine amphibian and reptile project.)

Attainment

Projects being developed include: 1) evaluating the longevity and use of standing dead trees as cavity nesting sites; 2) describing the distribution of breeding Brown-Headed Cowbirds in forested landscapes; 3) describing the effects of small openings on breeding bird habitat occurance of vespertilionid bats in forest dominated landscapes on the White Mountain National Forest; and 5) describing the silvicultural effects of mixedwood intermediate stand treatments on small mammals.

Problem 3 **Need to preserve undisturbed areas to study natural succession and impacts of global change**
FY 93 Research Attainments

Publications

Research Unit

DeGraaf, R.M.; Yamasaki, M.; Leak, W.B.; Lanier, J.W. New England wildlife management of forested habitats [Video recording]. Durham, NH: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1993. 17 min.

Leak, W.B.; Yamasaki, M.; Smith M.L.; Funk, D.T. 1993. Selection criteria for forested natural areas in New England. In: Conservation in working landscapes: 20th annual natural areas conference; 1993 June 22-26; Orono, ME. [Place of publication unknown]: [Publisher name unknown]: 46. Abstract.

Tyrell, Lucy E.; Funk, David T.; Lothner, David C. 1993 Research natural areas– U.S. Forest Service Eastern Region. In: Conservation in working landscapes: 20th annual natural areas conference; 1993 June 23-26; Orono, ME. [Place of publication unknown]: [Publisher name unknown]: 96. Abstract.

Extramural

Carbonneau, Lee E.; Allen, Sarah D. 1993. A botanical survey of the Bowl Research Natural Area. In: Conservation in working landscapes; 20th annual natural areas conference; 1993 June 22-26; Orono, ME. [Place of publication unknown]: [Publisher name unknown]: 88. Abstract.

Hulleburg, Thomas A.; Eckert, Robert T. 1993. Genetic variation in old-growth spruce. In: Conservation in working landscapes; 20th annual natural areas conference; 1993 June 22-26; Orono, ME. [Place of publication unknown]: [Publisher name unknown]: 71. Abstract.

Selva, Steven B. 1993. Lichen diversity and stand continuity in the forests of northern New England and Western New Brunswick. In: Conservation in working landscapes: 20th annual natural areas conference; 1993 June 22-26; Orono, ME. [Place of publication unknown]: [Publisher name unknown]: 72. Abstract.

Attainment

New Research Natural Areas (RNA's) have been added to the national network and others were screened for possible inclusion. A preliminary protocol for establishing permanent plots in RNA's has been completed and a national meeting will be held this year to adopt a final version.

Botanical surveys were completed for three existing RNA's and contracts have been awarded for three additional surveys. Several papers on lichens associated with old-growth forests were completed in the past year and additional work continues in the RNA's.

Problem 4 **Need to preserve integrity of older plantations to document responses to environmental change**
FY 93 Research Attainments

Publications

Research Unit

Garrett, Peter W. 1992. Performance of Himalayan blue pine in the northeastern United States. Tree Planters Notes. 43 (3): 76-80.

Attainment

Discussions were held with key operators to preserve the integrity of plantings on non-federal lands. During the upcoming year, all plantations of white pine, sugar maple, spruce, and pine hybrids will be reviewed and relabled and a remeasurement schedule will be established. All cooperators will be contacted and cooperative agreements extended to protect these plantings.

Problem M5 **A lack of mass production techniques prevents large-scale planting of pitch/loblolly pine hyb.**
FY 93 Research Attainments

Publications

none

Attainment

The pitch x loblolly hybrid pine program has produced a large number of desirable combinations for different geographical areas and site conditions. It is easy to make controlled crosses but very labor intensive to produce any quantity of F1 hybrid seed. This problem was designed as a means of mass producing commercial quantities of seed. One potential method involved the planting of grafted orchards of a single clone pitch pine and pollinating with a selected mix of loblolly parents using a mist-blower to deliver the pollen. Pitch pine that would not produce selfed offspring were selected for this program. If orchards were isolated from outside sources of pitch pollen then the entire crop theoretically would be F1 seed. Several orchards were established but the project was closed before pollination could take place. Another method would be to rogue some of the 65 F1 plantings to leave the most desirable individuals and let them cross naturally to produce F2 seed. There is a concern that material would look like pure pitch, pure loblolly, and some would contain intermediate characteristics of both. That would produce a wide variety of planting stock, which would be undesirable for commercial planting operations. We did produce a number of F2 hybrids to look at variation but that work has not been evaluated at this time. Cooperators in the program have gone ahead and started roguing plantations on their property in an effort to produce large quantities of seed. Based on performance of parent trees in the F1 plantings, we have been able to provide some guidance for roguing in specific regions of the country.

Northeastern Forest Experiment Station
Forest Environment Research
Research Work Unit 4251

Wildlife Communities and Habitat Relationships in New England Forests
DeGraaf, Richard M., Project Leader

FY 93 Research Attainments
Research Work Unit Summary

Problem number and title	Functional account	Current funding	Current staffing	Research Outputs		
				Research unit	Extra-mural	Cooper-ative
		thousand dollars	*scientist years*			
1. Wildlife community responses to alternative silvicultural systems in northern hardwoods	FER	527	1.0	1		
2. Relationships between stand structure and abundance of mammals in New England oak forests	FER	127	1.0	3	1	
3. Effects of forest management on amphibians and amphibian habitats in a changing global env.	FER	82	1.0	1	1	

Problem 1 **Wildlife community responses to alternative silvicultural systems in northern hardwoods**
FY 93 Research Attainments

Publications

Research Unit

DeGraaf, Richard M.; Yamasaki, Mariko. 1992. A nondestructive technique to monitor the relative abundance of terrestrial salamanders. Wildlife Society Bulletin. 20 (3): 260-264.

Attainment

A nondestructive technique was developed to monitor the relative abundance of terrestrial salamanders in even-aged northern hardwood stands. Redback salamanders occurred in regenerated clearcuts that were 14-20 years old, but lower numbers than in adjacent sawtimber stands. Numbers observed in poletimber stands (50 years old) were not different from those in adjacent sawtimber stands. Mean litter depth was not significantly different among forest size-classes.

These results were obtained using boards to simulate logs. Counts could therefore be made during the day and without degrading the habitat by turning or breaking log habitat.

Problem 2 **Relationships between stand structure and abundance of mammals in New England oak forests**
FY 93 Research Attainments

Publications

Research Unit

Healy, William M. 1992. Population influences: behavior. In: Dickson, James G., comp., ed. The wild turkey - biology and management. Harrisburg, PA: Stackpole Books: chapter 5.

Healy, William M. 1992. Population influences: environment. In: Dickson, James G., comp., ed. The wild turkey - biology and management. Harrisburg, PA: Stackpole Books: chapter 10.

Welsh, Christopher J.E.; Healy, William M. 1993. Effect of even-aged timber management on bird species diversity and composition in northern hardwoods of New Hampshire. Wildlife Society Bulletin. 21 (2): 143-154.

Extramural

Decker, Thomas A.; Healy, William M.; Williams, Steven A. 1992. Survival of white-tailed deer fawns in western Massachusetts. Northeast Wildlife. 49 (1): 28-35.

Attainment

Thinning New England oak stands had no measurable effect on small mammal populations. Deer density, however, did effect small mammal species richness and the relative abundance of several species. Four small mammal species were observed in stands where deer density exceeded 30 per sq. mi. and no silviculture had been applied. Seven species were observed in stands where deer density was less than 15 per sq. mi. White-footed mice were captured more frequently in areas with few deer. Thinning to promote the growth of sawtimber according to accepted guidelines and practices for New England had less effect on stand structure and plant species composition than browsing by white-tailed deer.

Thinning had a positive effect on acorn production in these stands. Both thinned and untreated stands produced large numbers of acorns during 3 years in which acorn crops were good or excellent. Estimates of the numbers of sound acorns per ha. ranged from 30,167 to 155,416 for untreated stands and 58,583 to 220,750 for thinned stands. On the average, thinned stands produced 1.4-1.9 times more sound acorns per ha. than did untreated stands. The relative differences between thinned and untreated stands were greatest when the acorn crop was smallest.

Problem 3	**Effects of forest management on amphibians and amphibian habitats in a changing global env.** **FY 93 Research Attainments**

Publications

Research Unit

Brooks, Robert T.; Barnard, Joseph E.; Burkman, William G. 1993. Detection-level forest health monitoring in the United States, 1990-1991. In: Tesche, M.; Fieler, S., eds. Air pollution and interactions between organisms in forest ecosystems; 1992 September 9-11; Dresden, Germany. Dresden, Germany: Technische Universitat Dresden: 54-58.

Extramural

Radloff, David L.; Barnard, Joseph E.; Brooks, Robert T.; Loomis, Robert C. 1992. Monitoring the health of forest ecosystems in the U.S.A. In: Tesche, M.; Feiler, S., eds. Air pollution and interactions between organisms in forest ecosystems; 1992 September 9-11; Dresden, Germany. Dresden, Germany: Technische Universitat Dresden: 49-53.

Attainment

Four temporary ponds have been identified and selected as study sites. Each pond has been enclosed by a drift fence with pit-fall traps located at 5-m intervals on both the pond-side and upland-side of the fence. Amphibian immigration and emigration to the ponds was quantified by species and date. Pond macro-inverterbrates were surveyed by use of: 1) core samples, 2) dip-net samples, and 3) artificial substrate samples. Pond water levels and simple water chemistry were monitored on a weekly basis. Each pond catchment was topographically surveyed along a metric grid. Catchment- and pond- basin vegetation was sampled on the grid. A study of hydrology of each pond has been initiated. Precipitation and deposition inputs are monitored at an adjacent NADP site.

Northeastern Forest Experiment Station
Forest Environment Research
Research Work Unit 4301

Water Resource Protection in Central Appalachian Forests
Adams, Mary Beth, Project Leader

FY 93 Research Attainments
Research Work Unit Summary

Problem number and title	Functional account	Current funding	Current staffing	Research Outputs		
				Research unit	Extra-mural	Cooper-ative
		thousand dollars	*scientist years*			
1. Minimizing hydrologic impacts of surface disturbances from forest access and harvest	FER	317	2.0	1		4
2. Impact of atmospheric deposition on the soil and water resources of Appalachian forests	FER	340	2.0	5	5	12

Problem 1 **Minimizing hydrologic impacts of surface disturbances from forest access and harvest**
FY 93 Research Attainments

Publications

Research Unit

Godwin, Marc Layne; Wood, Frederica; Adams, Mary Beth; Eye, Maxine C. 1993. Annotated bibliography of research related to the Fernow Experimental Forest. Gen. Tech. Rep. NE-174. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 131 p.

Cooperative

Dubey, Tara; Stephenson, Steven L.; Edwards, Pamela J. 1993. The possible effects of Diflubenzuron on the growth, sporulation, and enzymatic activities of aquatic hyphomycetes. Inoculum. Athens, GA: Mycological Society of America. 44: 34. Abstract.

Dubey, Tara; Stephenson, Steven L.; Edwards, Pamela J. 1993. Effect of DIMILIN on the growth, sporualtion, and enzymatic activities of the aquatic Hyphomycetes in streams of the Fernow Experimental Forest under natural conditions and in laboratory culture. In: Proceedings of the West Virginia Academy of Science: Papers of the 68th annual session; 1993 April 3; Elkins, WV. Morgantown, WV: West Virginia Academy of Science, Inc.: 65(1): 16. Abstract.

Kochenderfer, James; Smith, H. Clay; West Virginia University Extension Service. 1993. Protecting forest stream quality: a practical guide to best management practices. Video. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 25 min.

Stephenson, Steven L.; Kumar, Ashok; Bhatt, Rajendra P.; Adams Mary Beth. 1993. A comparative ecological and taxonomic study of the ectomycorrhizal fungi associated with the upland forest communities of northwestern India and the mid-Appalachians of the eastern United States. In: Proceedings of the West Virginia Academy of Science: Papers of the 68th annual session; 1993 April 3; Elkins, WV. Morgantown, WV: West Virginia Academy of Science, Inc.: 65(1): 27. Abstract.

Attainment

NE-4301 continues to broaden the scope of research on effects of forest management activities, with the initiation of research on the effects of management activities on aquatic biota. Included in this research is an evaluation of several management activities on aquatic invertebrates and development of biomonitoring protocols for central Appalachian streams. This research is in direct response to needs expressed by the Monongahela National Forest. More traditional road research also continues. Publication of "Annotated Bibliography of Research Related to the Fernow Experimental Forest" provided succinct summaries of 40 years of forest management and hydrologic research. Effects of gypsy moth control, through the use of DIMILIN, on aquatic biota are described in several papers presented at the West Virginia Academy of Sciences meeting. A video, "Protecting Forest Stream Quality: A practical guide to best management practices," summarizes many years of research on forest roads and provides valuable practical information to landowners, loggers, and the general public.

Problem 2 **Impact of atmospheric deposition on the soil and water resources of Appalachian forests**
FY 93 Research Attainments

Publications

Research Unit

Adams, Mary Beth; Kochenderfer, James N.; Edwards, Pamela J.; Angradi, Theodore. 1993. Research on acidic deposition and other air pollutants at the Fernow Experimental Forest. In: Proceedings of the West Virginia Academy of Science: Papers of the 68th annual session; 1993 April 3; Elkins, WV. Morgantown, WV: West Virginia Academy of Science, Inc.: 65(1): 1. Abstract.

Adams, Mary Beth. 1993. Acidic deposition effects on high-elevation red spruce forests. In: Proceedings of the West Virginia Academy of Science: Papers of the 68th annual session; 1993 April 3; Elkins, WV. Morgantown, WV: West Virginia Academy of Science, Inc.: 65(1): 6. Abstract.

Edwards, P.; Kochenderfer, J.; Adams, M. 1993. Effects of repeated ammonium sulfate applications on soil leachate chemistry on the Fernow Experimental Forest in West Virginia, USA. In: Rasmussen, L.; Brydges, T.; Mathy, P., eds. Experimental manipulations of biota and biogeochemical cycling in ecosystems- approach- methodologies- findings; 1992 May 18-20; Copenhagen, Denmark. Ecosystems Res. Rep. 4. Brussels, Belgium: Commission of the European Communities: 122-124.

Edwards, Pamela J.; Kochenderfer, James N. 1993. Artifical watershed acidification on the Fernow Experimental Forest. In: Proceedings of the West Virginia Academy of Science 1991: Papers of the 66th annual session; 1991 April 6; Montgomery, WV. Morgantown, WV: West Virginia Academy of Sciences, Inc.; 63.2: 73-81.

Edwards, Pamela J.; Wood, Frederica. 1993. Field and laboratory quality assurance/quality control protocols and accomplishments for the Fernow Experimental Forest watershed acidification study. Gen. Tech. Rep. NE-177. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 15 p.

Cooperative

Aulick, Staci D.; Gilliam, Frank S.; Evans, Dan K.; Adams, Mary Beth. 1993. A study of herbaceous layer communities in a central Appalachian mixed hardwood forest. In: Proceedings of the West Virginia Academy of Science: Papers of the 68th annual session; 1993 April 3; Elkins, WV. Morgantown, WV: West Virginia Academy of Science, Inc.: 65(1):29. Abstract.

Dubey, Tara; Stephenson, Steven L.; Edwards, Pamela J. 1993. Aquatic fungi associated with West Virginia mountain streams. Inoculum. Athens, GA: Mycological Society of America. 44: 34. Abstract.

Dubey, Tara; Stephenson, Steven L.; Edwards, Pamela J. 1993. The effects of acidification on the aquatic fungi associated with West Virginia mountain streams. In: Proceedings of the West Virginia Academy of Science: Papers of the 68th annual session; 1993 April 3; Elkins, WV. Morgantown, WV: West Virginia Academy of Science, Inc.: 65(1): 14. Abstract.

Gilliam, Frank S.; Adams, Mary Beth. 1993. Precipitation chemistry for West Virginia Appalachian forest sites: temporal and spatial variation. In: Proceedings of the West Virginia Academy of Science: Papers of the 68th annual session; 1993 April 3; Elkins, WV. Morgantown, WV: West Virginia Academy of Science, Inc.; 65(1):4. Abstract.

Gilliam, Frank S.; Turrill, Nicole L.; Adams, Mary Beth. 1993. Tree species composition of young vs. mature montane hardwood forests of West Virginia. In: Proceedings of the West Virginia Academy of Science 1993: Papers of the 68th annual session; 1993 April 3; Elkins, WV. Morgantown, WV: West Virginia Academy of Science, Inc.: 65(1): 33. Abstract.

Jackson, William A.; Iskra, Alan; Edwards, Pamela J. 1992. Characterization of ozone symptoms on native vegetation at the Dolly Sods and Otter Creek Wilderness. In: Berglund, Ronald L., ed. Proceedings, Tropospheric ozone and the environment II; 1992 November 4-7; Atlanta, GA. Pittsburgh, PA: Air and Waste Management Association: 526-536.

McQuattie, Carolyn J.; Stephenson, Steven L.; Edwards, Pamela J. 1993. Effect of stream acidity on decomposition of sugar maple (Acer saccharum) and red oak (Quercus rubra) leaves. In: The Ohio Journal of Science. 92(2):48. Abstract.

Pauley, Thomas K.; Kochenderfer, James. 1993. Potential impacts of an artificially acidified watershed on forest salamanders. In: Proceedings of the West Virginia Academy of Science: Papers of the 68th annual session; 1993 April 3; Elkins, WV. Morgantown, WV: West Virginia Academy of Science, Inc.: 65(1):2. Abstract.

Pauley, Thomas K.; Ordiway, Linda; Kochenderfer, James. 1993. Terrestrial and stream salamanders of the Fernow Experimental Forest, Parsons, WV. In: Proceedings of the West Virginia Academy of Science: Papers of the 68th annual session; 1993 April 3; Elkins, WV. Morgantown, WV: West Virginia Academy of Science, Inc.: 65(1): 49. Abstract.

Stephenson, Steven L.; McQuattie, Carolyn J.; Edwards, Pamela J.; Studlar, Susan M. 1993. The effect of acidification on the bryophytes associated with mountain streams. In: Smith, Elizabeth R., ed. Proceedings 3rd annual southern Appalachian man and the biosphere conference; 1992 November 9-10; Gatlinburg, TN. Norris, TN: Tennessee Valley Authority: 66. Abstract.

Stephenson. Steven L.; Studlar, Susan M.; McQuattie, Carolyn J.; Edwards, Pamela J. 1993. The effects of acidification on the bryophytes associated with West Virginia mountain streams. In: Proceedings of the West Virginia Academy of Science: Papers of the 68th annual session; 1993 April 3; Elkins, WV. Morgantown, WV: West Virginia Academy of Science, Inc.: 65(1): 15. Abstract.

Turrill, Nicole L.; Gilliam, Frank S.; Adams, Mary Beth. 1993. Variations of herb layer-soil relationships in young vs. mature stands of northeastern West Virginia Forests. In: Proceedings of the West Virginia Academy of Science: Papers of the 68th annual session; 1993 April 3; Elkins, WV. Morgantown, WV: West Virginia Academy of Science, Inc.: 65(1): 31. Abstract.

Extramural

Adams, M.B.; Turner, R.S.; Schmoyer, D.D. 1992. Evaluation of the Direct/Delayed Response Project soil sampling classes: northeastern United States. Soil Science Society of America Journal. 56 (1): 177-187.

Adams, Mary Beth; Eagar, Christopher. 1992. Impacts of acidic deposition on high-elevation spruce-fir forests: results from the Spruce-Fir Research Cooperative. Forest Ecology and Management. 51: 195-205.

Aulick, Stacie Dudash Smith. 1993. Vascular flora of three watersheds in the Fernow Experimental Forest and factors influencing species composition of the herbaceous layer. Huntington, WV: Marshall University. 74 p. M.S. thesis.

Griffith, Michael B.; Perry, Sue A. 1992. Trichoptera of the headwater streams in the Fernow Experimental Forest, Monongahela National Forest, West Virginia. Entomological News. 103 (4): 110-116.

Turrill, Nicole Leigh. 1993. Factors influencing herbaceous layer vegetation of a central Appalachian hardwood forest ecosystem. Huntington, WV: Marshall University. 87 p. M.S. thesis.

Attainment

NE-4301 has developed a reputation for expertise in the field of air pollution effects on forests of the Central Appalachians. This reputation is built on extensive research by the NE-4301 scientists and cooperative researchers, who dominated presentations at the 1993 West Virginia Academy of Sciences meeting special Symposium on Acid Rain. The publication "Characterization of Ozone Symptoms on Native Vegetation at the Dolly Sods and Otter Creek Wildernesses" provides useful information for forest managers and those who deal with the public on air pollution related concerns. The publication "Field and Laboratory Quality Assurance/Quality Control Protocols and Accomplishments for the Fernow Experimental Forest Watershed Acidification Study" details sample handling and laboratory protocols to provide data of exceptional quality, as required by EPA, and thus provides valuable information to other scientists, as well as validation of Fernow data. The Watershed Acidification Project is in its fifth year of treatment, making it a unique research project.

Northeastern Forest Experiment Station
Forest Environment Research
Research Work Unit 4351

Enhancement of the Human Habitat Through Management of Natural Environments
Corbett, Edward S., Project Leader

FY 93 Research Attainments
Research Work Unit Summary

Problem number and title	Functional account	Current funding	Current staffing	Research Outputs: Research unit	Research Outputs: Extra-mural	Research Outputs: Cooperative
		thousand dollars	*scientist years*			
2. Quantifying cumulative effects of atmospheric deposition, biotic factors and multiple use mgt.	FER	205	1.9	2		7
M1. Long-term watershed studies	FER	11	.1			

Problem 2 **Quantifying cumulative effects of atmospheric deposition, biotic factors and multiple use mgt.**
FY 93 Research Attainments

Publications

Research Unit

Corbett, E.S.; Lynch, J.A.; Shiels, Roxanne. 1993. Source area contributions to four palustrine wetlands using a three-component tracer model. EOS, Transactions, American Geophysical Union. 74(16) [Suppl.]: 141. Abstract.

Corbett, Edward S. 1991. Gypsy moth defoliation impacts on water quality and quantity. In: Gottschalk, Kurt W.; Twery, Mark J., eds. Proceedings U.S. Department of Agriculture interagency gypsy moth research forum 1991; 1991 January 14-17; Annapolis, MD. Gen. Tech. Rep. NE-167. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 31. Abstract.

Cooperative

Dietterick, B.C.; Lynch, J.A.; Corbet, E.S. 1993. Climatic change and the hydrologic cycle - an evaluation of surface runoff processes using TOPMODEL. EOS, Transactions, American Geophysical Union. 74(16)[Suppl.]: 195. Abstract.

Dunson, William A.; Wyman, Richard L.; Corbett, Edward S. 1992. A symposium on amphibian declines and habitat acidification. Journal of Herpetology. 26 (4): 349-352.

Gentry, Claud E.; Wade, Gary L.; Davidson, Walter H. 1993. Effects of tree species on soil development and humus composition in minesoils. In: Zamora, Benjamen A., Connoly, Randall E., eds. The challenge of integrating diverse perspectives in reclamation: Proceedings of the 10th annual national meeting of the American Society for Surface Mining and Recl.; 1993 May 16-19; Spokane, WA. ASSMR10-93. Princeton, WV: American Society for Surface Mining and Reclamation: 815-827.

(Copies of the proceedings must be purchased from ASSMR, 21 Grandview Drive, Princeton, WV 24740)

Grimm, J.W.; Lynch, J.A.; Corbet, E.S. 1993. Enhancement of regional wet deposition estimates using modeled precipitation inputs. EOS, Transactions, American Geophisical Union. 74(16)[Suppl.]: 194. Abstract.

Lynch, J.A.; Shiels, Roxanne; Corbett, E.S. 1993. Hydrochemical fluctuations in four palustrine wetlands in central Pennsylvania. EOS, Transactions, American Geophysical Union. 74(16)[Suppl.]: 144-145. Abstract.

Lynch, James A.; Horner, Kevin S.; Grimm, Jeffery W.; Corbett, Edward S. 1993. Atmospheric deposition: spatial and temporal variations in Pennsylvania – 1992. University Park, PA: The Pennsylvania State University, Environmental Resources Research Institute; ER930A. 376 p.

(Publication contains specific chemical analyses, statistics, trends, and maps of ionic concentrations and deposition.)

Lynch, James A.; Horner, Kevin S.; Grimm, Jeffery W.; Corbett, Edward S. 1993. Atmospheric deposition: spatial and temporal variations in Pennsylvania – 1992. University Park, PA: The Pennsylvania State University, Environmental Resource Research Institute; ER9304. 94 p.

(An analysis of State-wide atmospheric deposition data including 11 year trends.)

Attainment

A study of the linkages between pond chemistry and hydrologic source areas was undertaken in four temporary forest ponds while looking at amphibians as bioindicators of environmental change. We found that saturated subsurface flow of infiltrated storm water through the soil profile and pond interception of precipitation were the principal sources of storm water reaching each pond. Calculated soil water volumes were compared to estimates based on fluctuations in silica and sulfate concentrations in the ponds, soil water, and throughfall using a three-component tracer model. Soil water contributions based on silica concentration fluctuations were consistently closer to calculated volumes than estimates based on sulfate concentrations. Fluctuations in pond chemistry were controlled by the chemistry of subsurface saturated flow. Pond acidification and the subsequent impacts on the reproductive success of amphibians breeding in these ponds were closely associated with the hydrologic flow-paths and source-area chemistry. Ponds dominated by a rapid drainage through acedic forest soils were most susceptable to acidification. A basin hydrologic model, TOPMODEL, is being evaluated for its abiltity to provide reliable water yield estimates over a wide range of watershed conditions. Results indicate baseflow discharges are too high during periods when the soil moisture deficit is high. Altering the ET component and adding a leakage component are potential solutions being evaluated. The results of this evaluation will determine the utility of TOPMODEL to perform reliably for detailed climate and land-use change simulations. A soils analysis has shown that tree species do influence soil horizon development and humus composition on reclaimed sites. Factors which promote litter decomposition are also conductive to podzolization in young soils. Fungi are more important decomposers than bacteria in acid soils.

Problem M1	Long-term watershed studies FY 93 Research Attainments

Publications

none

Attainment

This problem is active in long-term studies on the effects of vegetation changes on hydrologic response and water quality. Data collection, data compilation, and instrument maintenance have been the primary activity this year.

Northeastern Forest Experiment Station
Forest Environment Research
Research Work Unit 4352

Dynamics of Atmosphere, Vegetation, Soil & Water in Mature & Harvested Forests in New England

Eagar, Christopher, Project Leader

FY 93 Research Attainments
Research Work Unit Summary

Problem number and title	Functional account	Current funding	Current staffing	Research Outputs		
				Research unit	Extra-mural	Cooper-ative
		thousand dollars	*scientist years*			
1. To what degree do harvesting and/or acid precip. deplete nutrient capitals of New England	FER	447	2.6	2		2
2. What is the sequence of regeneration following conventional and intensive harvesting in forests	FER	59	.2			2
3. How can we predict the progression of diameter growth for the major tree species in the NE	FER	0	.0			
4. What are the implications of highly acidic Cone Pond for understanding acidification of ecosystems	FER	304	.5			
5. Pathways of water and nutrient movement through forest soils. Can a useful model be developed?	FER	136	1.2			2
M1. The HBEF will be maintained for ecosystem research biosphere reserve and for LTER	FER	324	1.5	2	4	3

Problem 1 **To what degree do harvesting and/or acid precip. deplete nutrient capitals of New England**
FY 93 Research Attainments

Publications

Research Unit

Harris, M.M.; Safford, L.O. 1992. A rapid technique for drying organic soil horizons using a microwave oven. Soil Science. 154 (5): 420-425.

Pierce, Robert S.; Hornbeck, James W.; Martin, C. Wayne; Tritton, Louise M.; Smith, C. Tattersall; Federer, C. Anthony. 1993. Whole-tree clearcutting in New England: manager's guide to impacts on soils, streams, and regeneration. Gen. Tech. Rep. NE-172. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 23 p.

Cooperative

Hertel, G.D.; Eagar, C.; Medlarz, S.A.; McFadden, M.W. 1993. The effects of acidic deposition and ozone on forest tree species in the Eastern United States: results from the Forest Response Program. In: Huettl/Muller-Dombois, comp., ed. Forest decline in the Atlantic and Pacific Region. Berlin, Germany: Springer-Verlag: 54-65.

Holdren, George R., Jr.; Strickland, Timothy C.; Cosby, Bernard J.; Marmorek, David; Santore, Robert; Driscoll, Charles T. 1993. A national critical framework for atmospheric deposition effects assessment: IV. model selection, applications, and critical loads mapping. Environmental Management. 17 (3): 335-363.

Attainment

Intensive harvest operation in New England forests have shifted partially from conventional stem-only clearcutting using chainsaws and skidders to whole-tree harvesting using highly automated equipment for felling and forwarding trees to roadsides. Watershed ecosystem analysis was applied to determine how this contemporary approach to harvesting affects parameters such as streamwater quality, erosion, nutrient cycling, and nutrient and biomass removal. Studies were conducted in spruce-fir, northern hardwood, and central hardwood forest types. These studies have resulted in published guidelines about whole-tree harvesting for use by practicing foresters, land managers, environmental protection agencies and the general public. The guidelines are being incorporated by national forests in New England as part of their effort to implement ecosystem management. A procedure was developed for rapidly drying organic soil horizons in a microwave oven. This study is continuing to determine the applicability of drying organic soil horizons for analysis of chemical properties. Studies are continuing to evaluate the effects of changes in the physical and chemical environment on soil processes including nitrogen mineralization and dissolved organic carbon.

A review of models associated with the critical loads approach for evaluating the effects of atmospheric deposition on sensitive terrestrial and aquatic ecosystems has been completed. Different approaches are characterized by different levels of uncertainty. Approaches include emperical and statistical relationships, steady-state and simple process models, and integrated-effects models.

Problem 2 **What is the sequence of regeneration following conventional and intensive harvesting in forests**
FY 93 Research Attainments

Publications

Cooperative

Gove, Jeffery H.; Martin, C. Wayne; Patil, Ganapati P.; Solomon, Dale S.; Hornbeck, James W. 1992. Plant species diversity on even-aged harvests at the Hubbard Brook Experimental Forest: 10-year results. Canadian Journal of Forest Research. 22 (11): 1800-1806.

Thurston, Sally W.; Krasney, Marianne E.; Martin, C. Wayne; Fahey, Timothy J. 1992. Effect of site characteristics and 1st- and 2nd-year seedling densities on forest development in a northern hardwood forest. Canadian Journal of Forest Research. 22: 1860-1868.

Attainment

Successful regeneration following harvesting of the northern hardwood forest is essential for sustaining the forest resources of New England. Currently, there is little knowledge of vegetation changes during the first 30 years after a severe disturbance. Two published articles address these issues. Gove et. al. reported that following clearcutting in northern hardwoods, plant species diversity was lowest the year following cutting and was at its highest 10 years after cutting. Diversity seemed to begin to decline at about 10 years. Also, diversity was greater on a strip-cut than on a block clearcut.

Thurston et. al. examined factors affecting initial colonization and survival of tree species over 18 years. Micro site conditions were the most important factors for cherries and birches. Seed supply and sprouting were the most important for ash. Sugar maple and beech occurred extensively and survived well independently of the factors reviewed in the study.

Problem 3 **How can we predict the progression of diameter growth for the major tree species in the NE**
FY 93 Research Attainments

Publications

none

Attainment

The following reflects major accomplishments for the life of this problem. A regional sample of tree-ring measurements was used to determine average annual growth for 10 major species in New England. There have been extended periods of decreasing growth rates in red spruce since about 1960 and in balsam fir since about 1965. The other eight species, which included sugar maple and white pine, showed consistant increasing growth. The decreases in growth rate in sampled red spruce and balsam fir were independent of physical site characteristics, elevation, and geographic location, indicating that regional factors were involved. Weather parameters and indexes were not closely correlated with growth rates, and the best predictive equation explained only 33% of the annual variation. Due to past land use and epidemics of the spruce budworm, much of the red spruce-balsam fir forest below 1000m in elevation can be considered to be functioning as even-aged. Historical growth information suggests that these trees should have reached maximum growth around 1960, and that decreasing growth rates since then may have been the result of normal aging.

Problem 4 **What are the implications of highly acidic Cone Pond for understanding acidification of ecosystems**
FY 93 Research Attainments

Publications

none

Attainment

Geologic weathering is the primary source for replacing nutrient losses resulting from atmospheric deposition and forest harvest. Thus estimates of weathering rates are useful for setting air quality standards and developing management guides for timber harvesting. This study is utilizing isotopes of strontium to obtain improved estimates of weathering rates. Since strontium is an analog for calcium, it becomes possible to determine calcium inputs to forest ecosystems, and to partition the inputs into geologic and atmospheric sources. At the Cone Pond watershed in central New Hampshire, weathering rates for calcium determined by this new and more powerful approach are about one tenth of those calculated by previous, less sensitive methods. Extremely low annual inputs from geologic weathering indicate that several precautions are needed in managing ecosystems similar to Cone Pond watershed. Improved measures of weathering rates will serve as an important, additional guide for protecting health and productivity of New England forests.

Problem 5 **Pathways of water and nutrient movement through forest soils. Can a useful model be developed?**
FY 93 Research Attainments

Publications

Cooperative

Aber, John D.; Driscoll, Charles; Federer, C. Anthony; Lathrop, Richard; Lovett, Gary; Melillo, Jerry M. 1993. A strategy for the regional analysis of the effects of physical and chemical climate change on biogeochemical cycles in northeastern (U.S.) forests. Ecological Modelling. 67: 37-47.

Aber, John D.; Federer, C. Anthony. 1992. A generalized, lumped-parameter model of photosynthesis, evapotranspiration and net primary production in temperate and boreal forest ecosystems. Oecologia. 92: 463-474.

Attainment

Forest productivity has been related to the climatic variables of temperature and precipitation by a new simulation model called PnET. This model simulates monthly leaf area index and relates transpiration to photosynthesis by assuming an inverse relation of water use efficient to vapor pressure deficit. Average monthly productivity and water budget, and average annual carbon allocation are then calculated for major forest cover types. A simulation of a 3 degree C increase in maximum temperature and a 25% decrease in precipitation produced widely differing productivity responses among cover types and current climates. PnNET is being used in a geographic information system to simulate productivity changes from various climate change scenarios in the northeastern United States. This work will be part of the Forest Service estimates of forest response to global change.

Problem M1 **The HBEF will be maintained for ecosystem research biosphere reserve and for LTER**
FY 93 Research Attainments

Publications

Research Unit

Eagar, Christopher; Miller-Weeks, Margaret; Gillespie, Andrew J.R.; Burkman, William. 1992. Summary report: forest health monitoring in the Northeast 1991. NE/NA-INF-115-92. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 13 p.

Hornbeck, James W.; Swank, Wayne T. 1992. Watershed ecosystem analysis as a basis for multiple-use management of eastern forests. Ecological Applications. 2 (3): 238-247.

Cooperative

Bormann, Bernard T.; Bormann, F. Herbert; Bowden, William B.; Pierce, Robert S.; Hamburg, Steve P.; Wang, Deane. 1993. Rapid N2 fixation in pines, alder, and locust: evidence from the sandbox ecosystem study. Ecology. 74 (2): 583-598.

Nicholas, N.S.; Zedaker, S.M.; Eagar, C. 1992. A comparison of overstory community structure in three southern Appalachian spruce-fir forests. Bulletin of the Torrey Botanical Club. 119 (3): 316-332.

Nicholas, N.S.; Zedaker, S.M.; Eagar, C.; Bonner, F.T. 1992. Seedling recruitment and stand regeneration in spruce-fir forests of the Great Smoky Mountains. Bulletin of the Torrey Botanical Club. 119 (3): 289-299.

Extramural

Lovett, Gary M.; Likens, Gene E.; Nolan, Scott S. 1992. Dry deposition of sulfur to the Hubbard Brook Experimental Forest: a preliminary comparison of methods. In: Schwartz, S.E.; Slinn, W.G.N., comps., eds. Precipitation scavenging and atmosphere - surface exchange. Philadelphia, PA: Hemisphere Publishing Corp.: 1391-1401.Vol.3.

Reiners, William A. 1992. Twenty years of ecosystem reorganization following experimental deforestation and regrowth suppression. Ecological Monographs. 62 (4): 503-523.

Reitsma, Leonard. 1992. Is nest predation density dependent? A test using artificial nests. Canadian Journal of Zoology. 70: 2498-2500.

Steele, Benjamin B. 1993. Habitat selection by breeding Black-throated Blue Warblers at two spatial scales. Ornis Scandinavica. 23: 33-42.

Attainment

The Ecosystem Management initiative calls for incorporating more science into management decisions. An article was published showing how watershed ecosystem analysis, the basis for research at the Hubbard Brook Experimental Forest, provides one form of scientific basis for ecosystem management.

A study seeking to account for N2 fixation and dry deposition using a lysimiter mass-balance approach was conducted at Hubbard Brook Experimental Forest. For the species and ecosystems studied, N added in precipitation and lost in drainage was unimportant relative to biological N2 fixation. An unexpected result was the extent of associative nitrogen fixation in the nitrogen budget of the two pine ecosystems.

Watershed 2 at Hubbard Brook was experimentally deforested in the winter of 1965-1966, and subsequent plant regeneration was suppressed until 1969. Changes in species structure, plant abundance, above ground primary productivity and biomass, and above ground nutrient polls were sampled during 1,2,3,5,11, and 20 years of subsequent succession. While recovery rate on watershed 2 was delayed in the first decade of regrowth, and composition was somewhat altered because of the 3 year suppression, this forest displayed a vigorous capacity for regeneration after suppression ceased.

A video entitled "The Hydrology of Hubbard Brook" was produced and was used at a national televideo conference "Water Quality and Our Forests" conducted by the Cooperative Extension Service of the University of Maine. The emphasis was on watershed management research and maintaining water quality during logging.

Northeastern Forest Experiment Station
Forest Protection Research
Research Work Unit 4454

Integrating the Ecological and Social Dimensions of Forest Ecosystem Management
Tritton, Louise M., Project Leader

FY 93 Research Attainments
Research Work Unit Summary

Problem number and title	Functional account	Current funding	Current staffing	Research Outputs		
				Research unit	Extra-mural	Cooper-ative
		thousand dollars	*scientist years*			
1. Methodologies for integrating ecological and social dimensions of forest management	FER	32	.3			
2. Application and evaluation of integrated approach to forest management problems.	FPR	287	1.3	6		2

Problem 1 **Methodologies for integrating ecological and social dimensions of forest management**
FY 93 Research Attainments

Publications

none

Attainment

In FY93 we continue to work on three areas within Problem 1. First, we are developing methodologies for defining, monitoring and evaluating integration and interdisciplinarity in forest ecosystem research and management. Cooperators with expertise in sociology and social ecology have provided us with: a review of literature; a review, synthesis and analysis of literature reporting case studies of interdisciplinary research efforts; and a report on the conceptual issues related to integration of disciplines and the integration of knowledge. We have been repeatedly invited to give the presentation entitled "Challenges to researchers as we integrate the ecological and social dimensions of forest ecosystem management." Publications are being written on these reports. Second, we are exploring the roles of value systems in promoting and limiting integration and interdisciplinarity. Cooperators with expertise in philosophy are assisting us in writing a publication entitled "Moral reasoning about sustainability in natural resource management." Third, our cooperators are developing a practical methodology for integrating the ecological and social dimensions of forest management by analyzing how research scientists and forest managers define ecosystem integrity, and how these concepts can be combined with public values to manage National Forests in New Hampshire and in Oregon.

Problem 2 **Application and evaluation of integrated approach to forest management problems.**
FY 93 Research Attainments

Publications

Research Unit

Chambers, Jeanne C.; MacMahon, James A.; Wade, Gary L. 1992. Differences in successional processes among biomes: importance in obtaining and evaluating reclamation success. In: Chambers, J.C.; Wade, Gary L., eds. Evaluating reclamation success: the ecological consideration – Proceedings of a symposium; 1990 April 23-26; Charleston, WV. Gen. Tech. Rep. NE-164. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 59-72.

Chambers, Jeanne C.; Wade, Gary L. 1992. Evaluating reclamation success using ecological principles: a holistic approach. In: Chambers, J.C.; Wade, Gary L., eds. Evaluating reclamation success: the ecological consideration – Proceedings of a symposium; 1990 April 23-26; Charleston, WV. Gen. Tech. Rep. NE-164. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 105-107.

Chambers, Jeanne C.; Wade, Gary L. 1992. Evaluating reclamation success: the ecological consideration – Proceedings of a symposium; 1990 April 23-26; Charleston, WV. Gen. Tech. Rep. NE-164. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 107 p.

(Work unit scientist and coauthor organized the symposium, proposed the proceedings and edited the same.)

Gentry, Claude E.; Wade, Gary L; Davidson, Walter H. 1993. Effects of tree species on soil development and humus composition in minesoils. In: Zamora, Benjamin A.; Connolly, Randall E., co-eds. The challenge of integrating diverse perspectives in reclamation: Proceedings, 10th annual national meeting of the American Society for Surface Mining and Reclamation; 1993 May 16-19; Spokane, WA. ASSMR10-93. Princeton, WV: American Society for Surface Mining and Reclamation: 815-827. Vol. 2.

Wade, Gary L; Thompson, Ralph L. 1993. Species richness on five partially reclaimed Kentucky surface mines. In: Zamora, Benjamin A.; Connolly, Randall E., co-eds. The challenge of integrating diverse perspectives in reclamation: Proceedings, 10th annual national meeting of the American Society for Surface Mining and Reclamation; 1993 May 16-19; Spokane, WA. ASSMR10-93. Princeton, WV: American Society for Surface Mining and Reclamation: 307-314. Vol. 1.

Wade, Gary L.; Tritton, Louise M. 1993. Evaluating biodiversity of natural areas. In: Conservation in working landscapes: 20th annual natural areas conference; 1993 June 22-26; Orono, ME. Orono, Maine: University of Maine: 90-91. Abstract.

Cooperative

Arthur, M.A.; Tritton, L.M.; Fahey, T.J. 1993. Dead bole mass and nutrients remaining 23 years after clear-felling of a northern hardwood forest. Canadian Journal of Forest Research. 23 (7): 1298-1305.

Pierce, Robert S.; Hornbeck, James W.; Martin, C. Wayne; Tritton, Louise M.; Smith, C. Tattersall; Federer, C. Anthony. 1993. Whole-tree clearcutting in New England: manager's guide to impacts on soils, streams, and regeneration. Gen. Tech. Rep. NE-172. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 23 p.

Attainment

In FY93, we continue the integration and analysis of the ecological, pathological, silvicultural, historical and economic data for a small northern hardwood forest. Annual cankers on sugar maples are most frequently found on steep, south-facing slopes associated with very shallow soils on either fine till or bedrock. Data on the economic cost of stem cankers on sugar maples were collected and the analysis is underway. Additional information on the association of root diseases is being collected by cooperators. For the integrated approach to plant species richness and management practices, we have presented at three national meetings a conceptual model for evaluating different types of biodiversity at spatial scales ranging from individual organisms to biomes. We are also developing a parallel model for identifying social values related to biodiversity at different spatial scales. We continue work on the species-area equations using regional and national data sets developed by cooperators.

Northeastern Forest Experiment Station
Forest Protection Research
Research Work Unit 4455

Northern Stations Global Change Research Program
Birdsey, Richard A., (PM), Project Leader

FY 93 Research Attainments
Research Work Unit Summary

Problem number and title	Functional account	Current funding	Current staffing	Research Outputs		
				Research unit	Extra-mural	Cooper-ative
		thousand dollars	*scientist years*			
1. Global Change Research	FPR	1812	1.2	2	43	1

Problem 1 **Global Change Research**
FY 93 Research Attainments

Publications

Research Unit

Birdsey, Richard A. 1992. Carbon storage and accumulation in the United States forest ecosystems. Gen. Tech. Rep. WO-59. Washington, D.C.: U.S. Department of Agriculture, Forest Service. 51 p.

Birdsey, Richard A.; Plantinga, Andrew J.; Heath, Linda S. 1993. Past and prospective carbon storage in United States forests. Forest Ecology and Management. 58: 33-40.

Cooperative

Plantinga, Andrew J.; Birdsey, Richard A. 1993. Carbon fluxes resulting from U.S. private timberland management. Climatic Change. 23: 37-53.

Extramural

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Attainment

Initiated the request for proposals and selection of research modeling efforts for a national modeling program. Workshops have been held to8 8 8 develop and integrate core models for the Forest Service national assessment of global change effects on forested ecosystems. Additional proposals for basic research studies on physiology, forest ecosystems, landscape level changes, social-economic effects, and modeling have been initiated. These new initiatives will build on the current research base in preparation for a major assessment of northern forest ecosystem responses to global change in 1995.

Research studies on eastern forest ecosystem response to acidic deposition and ozone stress are now being completed. Synthesis of the results of this large body of research appears in review articles which summarize and evaluate mechanisms which are responsible for foliar injury and reductions in winter hardiness in red spruce.

Research results on forest soils processes, nutrient cycling, and canopy biochemistry at high pollution sites along gradients have helped our basic understanding of how forest ecosystems will respond to climate change.

New results from physiological studies have shown that the interaction of air pollutants may cause synergestic responses. These results have pointed out the need for multiple stress experiments, using CO2 and ozone. The carbon budget model has been refined and updated to look at carbon storage in U.S. forests and wood products. It has been utilized to answer policy questions on the potential for reducing carbon dioxide by sequestering carbon in U.S. forests.

Northeastern Forest Experiment Station
Forest Protection Research
Research Work Unit 4501

Ecology and Management of Northeastern Hardwood Insect Pests
Montgomery, Michael E., Project Leader

FY 93 Research Attainments
Research Work Unit Summary

Problem number and title	Functional account	Current funding	Current staffing	Research Outputs		
				Research unit	Extra-mural	Cooper-ative
		thousand dollars	*scientist years*			
1. Knowledge of factors governing susceptibility of trees to defoliation	FPR	106	1.0			4
2. Use of genetics, physiology & ecology to enhance biorational methods to manage gypsy moth	FPR	264	2.5	6	3	1
3. Reduce likelihood of establishment of Asian race of gypsy moth in North America	FPR	528	2.2	6		2
4. Influence of UV-B radiation on the balance between trees and their pests	FPR	53	.1			2
5. Implement a biological control program to reduce populations of hemlock woolly adelgid	FPR	106	.2			

Problem 1 **Knowledge of factors governing susceptibility of trees to defoliation**
FY 93 Research Attainments

Publications

Cooperative

Chilcote, Charley A.; Witter A.; Montgomery, Michael E.; Stoyenoff, Jennifer L. 1992. Intra- and inter-clonal variation in gypsy moth larval performance on bigtooth and trembling aspen. Canadian Journal of Forest Research. 22: 1676-1683.

(This publication was funded in part through a cooperative agreement with the work unit.)

Lindroth, Richard L. 1992. Nutritional ecology of gypsy moth - host interactions. In: Gottschalk, Kurt, W.; Twery J., eds. Proceedings U.S. Department of Agriculture interagency gypsy moth research forum 1992; 1992 January 13-16; Annapolis, MD. Gen. Tech. Rep. NE-170. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 30-31. Abstract.

Tobi, Donald R.; Leonard, Jonathan G.; Parker, Bruce L.; Wallner, William E. 1992. Survey methods, distribution, and seasonality of Korscheltellus gracilis (Lepidoptera: Hepialidae) in the Green Mountains, Vermont. Environmental Entomology. 21 (3): 447-452.

Tobi, Donald R.; Parker, Bruce L.; Wallner, William E. 1992. Feeding by Korscheltellus gracilis (Lepidoptera: Hepialidae) larvae on roots of spruce and fir. Journal of Economic Entomology. 85 (6): 2329-2335.

Attainment

Aspen clones exhibit substantial variation in resistance to defoliation by gypsy moths and in phenotypic glycoside concentrations. Initial results indicate that indifferential defoliation is a consequence of variation in aspen defensive chemistry and that the efficacy of gypsy moth management via Bt application may be affected by the chemical composition of aspen hosts.

The potential impact of the root feeding insect, Korscheltellus gracilis (Lepidoptera: Hepialidae) on high elevation red spruce and balsam fir was studied. Survey methods were developed and distribution and seasonality was determined. Economic effects may be associated with K. gracilis larval feeding on red spruce, first through possible mortality but almost assured reduction in value of mature trees and second, by loss of regeneration. K. gracilis may be contributing to the decline of red spruce throughout the Northeast.

Problem 2 **Use of genetics, physiology & ecology to enhance biorational methods to manage gypsy moth**
FY 93 Research Attainments

Publications

Research Unit

Kenna, Melody A.; ODell, Thomas M.; Tanner, John A. 1992. Abnormal performance syndrome in the gypsy moth: diet and parental effects. In: Gottschalk, Kurt W.; Twery, Mark J., eds. Proceedings U.S. Department of Agriculture interagency gypsy moth research forum 1992; 1992 January 13-16; Annapolis, MD. Gen. Tech.Rep. NE-170. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 25. Abstract.

ODell, T.M. 1992. Straggling in gypsy moth production strains: a problem for developing research priorities. In: Anderson, Thomas E.; Leppla, Norman C., comps., eds. Advances in insect rearing for research and pest management. Boulder, CO: Westview Press: 325-352.

Sanchez, Vince. 1992. Enzyme profiles and genetic variation in Compsilura concinnata (Diptera: Tachinidae). In: Gottschalk, Kurt W.; Twery, Mark J. eds. Proceedings U.S. Department of agriculture interagency gypsy moth research forum 1992; 1992 January 13-16; Annapolis, MD. Gen. Tech. Rep. NE-170. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 41. Abstract.

(Abstract of poster presentation)

Shields, Kathleen S. 1992. Nephrocytes of the gypsy moth, Lymantria dispar. In: Gottschalk, Kurt W.; Twery, Mark J. eds. Proceedings U.S. Department of Agriculture interagency gypsy moth research forum 1992; 1992 January 13-16; Annapolis, MD. Gen. Tech. Rep. NE-170. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 46-47. Abstract.

(Abstract of poster presentation)

Smith, Harvey R.; Cook, Steven P.; Hastings, Felton L.; Hain, Fred P. 1992. Population fluctuations and potential impact of small mammal predators of gypsy moth. In: Gottschalk, Kurt W.; Twery, Mark J. eds. Proceedings U.S. Department of Agriculture interagency gypsy moth research forum 1992; 1992 January 13-16; Annapolis, MD. Gen. Tech. Rep. NE-170. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 48-49. Abstract.

Willis, Raymond B.; Schwab, Gregory J.; Gentry, Claude E. 1993. Elimination of interferences in the colorimetric analysis of ammonium in water and soil extracts. Communications in Soil Science and Plant Analysis. 24 (9&10): 1009-1019.

(This work was performed by the senior author while working at a Northeastern unit in Berea, KY which has been closed.)

Cooperative

Skinner, Margaret; Parker, B.L.; Wallner, W.E; ODell, T.M.; Howard, Diantha; Aleong, J. 1993. Parasitoids in low-level populations of Lymantria dispar (Lepidoptera: Lymantriidae) in different forest physiographic zones. Entomophaga. 38 (1): 15-29.

(This publication was funded in part through a cooperative agreement between the USDA Forest Service and the University of Vermont.)

Extramural

Gould, Juli R.; Elkinton, Joseph S. 1990. Temperature-dependant growth of Cotesia melanoscela (Hymenoptera: Bracondiae), a parasitoid of the gypsy moth (Lepidoptera: Lymantriidae). Environmental Entomology. 19 (4): 859-865.

(This publication was funded in part through a cooperative agreement with the work unit and has not been previously reported.)

Gould, Juli R.; Elkinton, Joseph S.; Van Driesche, Roy G. 1992. Assessment of potential methods of measuring parasitism by Brachymeria intermedia (Nees) (Hymenoptera: Chalcididae) of pupae of the gypsy moth. Environmental Entomology. 21 (2): 394-400.

(This work was supported in part through a cooperative agreement with the work unit)

Gould, Juli R.; Elkinton, Joseph S.; Van Driesche, Roy G. 1992. Suitability of approaches for measuring parasitoid impact on Lymantria dispar (Lepidoptera: Lymantriidae) populations. Environmental Entomology. 21 (5): 1035-1045.

(This research was supported in part through a cooperative agreement with the work unit.)

Attainment

The cause of a gypsy moth rearing problem which significantly affected research, the production of nuclear polyhedrosis virus, and F1-sterile egg masses was determined. A dietary deficiency of available iron in two consecutive generations resulted in reduced egg hatch, slow asynchronus growth, and pupal abnormalities. The problem was eliminated by ensuring that the standard artificial diet contained the amorphous form of ferric phosphate, a commercially available mineral supplement. Two types of nephrocyte cells were identified and investigated for their role in gypsy moth physiology when larvae were infected with nuclear polyhedrosis virus. The observed changes in nephrocytes might play some role in insect defense.

Fluctuation of small mammal populations, driven in part by availability of alternative food sources, have an important impact on the dynamics of gypsy moth; sparse small mammal populations are critical to gypsy moth population change due to the rate of spread of new infestations.

Enzyme electrophoresis is being used to characterize and identify biotypes of biological control agents. Enzyme systems studied for the gypsy moth tachnid parasite, Compsilura concinnata, were found to provide sufficient resolution to establish population profiles. Several cooperative studies evaluated different methods for estimating the impact of parasitoids on gypsy moth populations. Biases associated with various methods depend on the biologies of specific agents. In sparse, relatively stable gypsy moth populations, evidence indicates parasitism is a dynamic process.

Problem 3 — Reduce likelihood of establishment of Asian race of gypsy moth in North America

FY 93 Research Attainments

Publications

Research Unit

Montgomery, Michael. 1992. Asian gypsy moth research update. In: 66th meeting, National Plant Board; 1992 July 26-29; Portland, ME. [Place of publication unknown]: [Publisher name unknown]: 119-120.

Montgomery, Michael E.; ODell, Carol A.B. 1993. USDA Forest Service Quarantine Laboratory. In: Souto, Dennis J., comp., Proceedings of the combined meeting of the Northeastern Forest Pest Council and the 25th annual northeastern forest insect work conference; 1993 March 8-10; Albany, NY. [Place of publication unknown]: [Publishers name unknown]: 56-57.

Montgomery, Michael E.; Wallner, William E. 1992. Insect pests of larch in Asia and their threat to larch in North America. In: Ecology and management of Larix forests: a look ahead; 1992 October 5-9; Whitefish, MT. Missoula, MT: The University of Montana: 25. Abstract.

ODell, Thomas M.; Xu, Chong-hua; Schaefer, Paul W.; Leonhardt, Barbara A.; Yao, De-fu; Wu, Xiang-de. 1992. Capture of gypsy moth, Lymantria dispar (L.), and Lymantria mathura (L.) males in traps baited with disparlure enantiomers and olefin precursor in the People's Republic of China. Journal of Chemical Ecology. 18 (12): 2153-2159.

ODell, Tom. 1993. Forest ghosts. In: Middlesex County Conservation District News. Summer: 1.

Smith, Harvey R.; Wallner, William E.; Procter, Nobel S. 1993. Small mammal predators: their role and potential in forest protection in the former Soviet Union. In: Proceedings 49th annual Northeast fish and wildlife conference; 1993 April 18-21; Atlantic City, NJ: 7. Abstract. [Place of publication unknown]: [Publisher name unknown].

Cooperative

Proctor, Noble S.; Smith, Harvey R.; Wallner, William E. 1992. Birding in the former Soviet Union: Moscow and Minsk. Birding. 24 (6): 356-362.

Schafer, Paul W.; Wallner, William E. 1992. Asian gypsy moth (AGM) bioecology: comparisons with North American gypsy moth and other species of Lymantria. In: Gottschalk, Kurt W.; Twery, Mark J., eds. Proceedings U.S. Department of Agriculture interagency gypsy moth research forum 1992; 1992 January 13-16; Annapolis, MD. Gen. Tech. Rep. NE-170. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 42. Abstract.

Attainment

Studies in the new Forest Service Quarantine Laboratory, Ansonia, CT, indicated that Asian gypsy moth (AGM) and North American gypsy moth (NAGM) are able to mate successfully and produce offspring which have a mixture of traits of both parents and show hybrid vigor. Flight attributes of female AGM, NAGM, and their offspring are being characterized, anatomy and histology of flight muscles are being compared, and larval feeding response to 50 native and exotic plants have been assessed. Comparison among gypsy moth forms worldwide indicates that the phenotypic expression of genetic variation is abundant, especially in the larval coloration. This variation raises questions as to species limits and points to the need for intensive genetic investigations.

The role of small mammal predators of gypsy moth and their potential in forest protection in the former Soviet Union has demonstrated that parallel studies between countries can accelerate evaluation of small mammal impact on pest insects.

Soviet methodology used to manage cavity-nesting birds and increase ther effectiveness as predators was observed. A 5-fold increase in numbers of birds in forests provisioned with nest boxes was documented; a study using nest boxes in the Northeastern U.S. is underway.

Experience with pests of Asian larch that have moved to North America indicates that their pestilance will be greater on North American species of larch.

Problem 4 — Influence of UV-B radiation on the balance between trees and their pests
FY 93 Research Attainments

Publications

Cooperative

Yang, Xiusheng; Miller, David R.; Montgomery, Michael E. 1993. Characteristics of ultraviolet-B radiation in hardwood forests. In: Abstracts, Joint meeting of northern and southern global change programs; 1993 June 8-9; Washington, DC. [Place of publication unknown]: [Publisher name unknown]: 38. Abstract.

Yang, Xiusheng; Miller, David R.; Montgomery, Michael E.; Luo, Yuxi; Ducharme, Kirk M. 1993. Transfer and distribution of biologically active radiation in a partially refoliated hardwood forest after gypsy moth defoliation. In: Proceedings 13th international congress of biometeorology; 1993 September 12-18; Calgary, AB. [Place of publication unknown]: [Publisher name unknown]: 163. Abstract.

Attainment

The biologically active radiation environment in a partially refoliated hardwood forest after gypsy moth defoliation was experimentally characterized with canopy analyzers and broadband radiation sensors. Results indicated that the top leaves would be most vulnerable to damages caused by ultraviolet-B (UVB, 280-320 nm). The long-term change in the flux ratio of UV-B and photosynthetically active (PAR, 400-700 nm) solar irradiance to monitor the forest adaptation to damage level from increased exposure to UV-B was recommended.

Problem 5 **Implement a biological control program to reduce populations of hemlock woolly adelgid**
FY 93 Research Attainments

Publications

none

Attainment

Potential predators of the hemlock woolly adelgid (HWA) were collected from infested hemlock. These included larval and adult derodontid beetles, coccinelid, neuropteran, syriphid larvae, and hemipteran nymphs. Derodontid beetles, previously observed in colonies of the pine bark adelgid, Pineus strobi, were observed feeding on all HWA life stages. Approximately 900 derodontid larvae (Family Derodontidae) were collected from HWA infested hemlock. These predators were only found on HWA infested hemlock which were near white pine infested with pine bark adelgid. Four hundred and twelve HWA larvae were released in two areas not previously occupied by the predator. The remaining larvae were reared to adult and an artificial diet was investigated.

Northeastern Forest Experiment Station
Forest Protection Research
Research Work Unit 4502

Pathology and Microbial Control of Insects Defoliating Eastern Forest Trees

McManus, Michael L., Project Leader

FY 93 Research Attainments
Research Work Unit Summary

Problem number and title	Functional account	Current funding	Current staffing	Research Outputs: Research unit	Research Outputs: Extra-mural	Research Outputs: Cooperative
		thousand dollars	*scientist years*			
1. Develop the technology needed to optimize the use of Bt to protect forests from defoliating insects	FPR	354	1.0	4	4	8
2. Improve production, enhance activity, and optimize application of GYPCHEK against gypsy moth	FPR	304	1.0	4	7	1
3. The effect of Bt application on the distribution and abundance of non-target Lepidoptera	FPR	189	1.0	3		
4. Introduce/establish exotic pathogens i.e. microsporidia to enhance natural control of GM.	FPR	107	.5	3		
M1. Develop and evaluate integrated pest management (IPM) strategies to manage the gypsy moth.	FPR	4	.2	1	4	2

Problem 1 **Develop the technology needed to optimize the use of Bt to protect forests from defoliating insects**
FY 93 Research Attainments

Publications

Research Unit

Dubois, Normand R. 1992. Recombinant DNA technology in Bacillus thuringiensis. In: Gottschalk, Kurt W.; Twery, Mark J., eds. Proceedings U.S. Department of Agriculture interagency gypsy moth research forum 1992; 1992 January 13-16; Annapolis, MD. Gen. Tech. Rep. NE-170. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 15-16. Abstract.

Dubois, Normand R. 1993. Is development of resistance to Bacillus thuringiensis a risk in forest protection? In: Souto, Dennis J., comp. Proceedings of the combined meeting of the northeastern forest pest council and the 25th annual northeastern forest insect work conference; 1993 March 8-10; Latham, NY. Syracuse, NY: College of Environmental Science & Forestry, State University of New York: 13-15.

Dubois, Normand R.; Reardon, Richard C.; Mierzejewski, Karl. 1993. Field efficacy and deposit analysis of Bacillus thuringiensis Foray 48B, against gypsy moth (Lepidoptera: Lymantriidae). Journal of Economic Entomology. 86 (1): 26-33.

Webb, R.E.; Shapiro, M.; Podgwaite, J.D.; Lynn, D.E.; Dougherty, E.M.; Ridgway, R.L. 1993. Field comparison of different strains of gypsy moth nuclear polyhedrosis virus against gypsy moth (Lepidoptera: Lymantriidae) in western Maryland in 1990. Journal of Economic Entomology. 86 (4): 1185-1190.

Cooperative

Anderson, Dean E.; Miller, David R.; Wang, Yansen; Yendol, William G.; Mierzejewski, Karl; McManus, Michael L. 1992. Deposition of aerially applied Bt in an oak forest and its prediction with the FSCBG model. In: Gottschalk, Kurt W.; Twery, Mark J., eds. Proceedings U.S. Department of Agriculture interagency gypsy moth research forum 1992; 1992 January 13-16; Annapolis, MD. Gen. Tech. Rep. NE-170. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 8. Abstract.

Anderson, Dean E.; Miller, David R.; Wang, Yansen; Yendol, William G.; Mierzejewski, Karl; McManus, Michael L. 1992. Deposition of aerially applied Bt in an oak forest and its prediction with the FSCBG model. Journal of Applied Meteorology. 31 (12): 1457-1466.

Baur, Leah S.; McCullough, Deborah G.; Dubois, Normand R. 1993. Using Bt to control gypsy moth. Ext. Bull. E-2421. East Lansing, MI: Michigan State University Extension. 2 p.

Mierzejewski, Karl; Nealen, Paul; Maczuga, Steven; Yendol, William; McManus, Michael. 1992. Spray deposit assessment system. In: Gottschalk, Kurt W.; Twery, Mark J., eds. Proceedings U.S. Department of Agriculture interagency gypsy moth research forum 1992; 1992 January 13-16; Annapolis, MD. Gen. Tech. Rep. NE-170. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 32. Abstract.

Mierzejewski, Karl; Reardon, Richard; McLane, Winfred; Dubois, Normand; Roland, Timothy; Yendol, William. 1993. Evaluation of three application rates of Bacillus thuringiensis: efficacy and deposit analysis. NA-TP-09-93. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Area, Appalachian Integrated Pest Management. 15 p.

Miller, D.R.; Yendol, W.G.; McManus, M.L. 1992. Field sampling of pesticide spray distributions using Teflon spheres and flat cards. In: Gottschalk, Kurt W.; Twery, Mark J., eds. Proceedings U.S. Department of Agriculture interagency gypsy moth research forum 1992; 1992 January 13-16; Annapolis, MD. Gen. Tech. Rep. NE-170. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 33. Abstract.

Sundaram, Alam; Sundaram, K.M.S.; Dubois, N.R.; Hammock, B.D. 1992. Deposition, persistence and fate of Bacillus thuringiensis var kurstaki in a hardwood forest, after aerial spraying of a commercial formulation at two dosage rates. In: Proceedings 19th International Congress of Entomology; 1992 June 28-July 4; Beijing, China. [Place of Publication unknown]: [Publisher name unknown]: 564. Abstract.

Wang, Y.S.; Miller, D.R.; Yendol, W.G.; McManus, M.L. 1992. Application of a Lagrangian stochastic model to aerial spray transport in an oak forest. In: Gottschalk, Kurt W.; Twery, Mark J., eds. Proceedings U.S. Department of Agriculture interagency gypsy moth research forum 1992; 1992 January 13-16; Annapolis, MD. Gen. Tech. Rep. NE-170. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 54. Abstract.

Extramural

Duan, Baozhong; Mierzejewski, Karl; Yendol, William G. 1992. A simplified model for the prediction of the evaporation rate of pesticide droplets aerially sprayed from aircraft. In: Gottschalk, Kurt W.; Twery, Mark J., eds. Proceedings U.S. Department of Agriculture interagency gypsy moth research forum 1992; 1992 January 13-16; Annapolis, MD. Gen. Tech. Rep. NE-170. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 14. Abstract.

Duan, Baozhong; Mierzejewski, Karl; Yendol, William G. 1992. A model for the prediction of the evaporation rate of pesticide droplets aerially sprayed from aircraft. Journal of Environmental Science and Health. B27 (6): 677-694.

Duan, Baozhong; Yendol, William G.; Mierzejewski, Karl; Reardon, Richard. 1992. Validation of the AGDISP aerial spray deposition prediction model. Pesticide Science. 36: 19-26.

Wang, Y.S.; Miller, D.R.; Welles, J.M.; Heisler, G.M. 1992. Spatial variability of canopy foliage in an oak forest estimated with fisheye sensors. Forest Science. 38 (4): 854-865.

Attainment

Laboratory studies were initiated to elucidate the importance of the spore/toxin interaction on the efficacy of Bt against gypsy moth larvae. Bioassay studies were conducted with purified insecticidal crystal proteins (ICP) of B. thuringiensis (Bt), pure Bt spores from a crystal negative mutant, and 16 bacterial species that are part of the microflora of the bark and leaves of a mixed oak-maple deciduous forest stand. Results indicate that maximum insecticidal activity requires both an active toxin binding to specific membrane receptors resulting in perforation of the wall of the midgut, and bacterial invasion into the hemolymph which results in the development of a lethal septicemia. The synergistic mechanism between ICP and bacteria had been assumed to be Bt spore specific. However, interaction between ICPs and some, but not all, of the 16 bacterial isolates were also observed. Differences in the intensity of the interactions were observed between various combinations of bacterial spores and specific ICPs, either cryIA(a) or cryIA(c). Some bacteria were as effective as the Bt spores and others had no observable effects. These observations suggest that the microflora composition of a forest stand could influence the apparent field effectiveness of applied Bt. Also, ICP genes cloned into and expressed in selected bacteria that are part of the natural microflora of these forest stands could be a very effective means of delivering Bt toxins. Studies have also been initiated to measure the effect of UV-B radiation on the degradation of commercial Bt formulations applied to oak foliage.

Problem 2 **Improve production, enhance activity, and optimize application of GYPCHEK against gypsy moth**
FY 93 Research Attainments

Publications

Research Unit

Podgwaite, John D. 1991. Gypchek production in vivo. In: Gottschalk, Kurt W.; Twery, Mark J., eds. Proceedings U.S. Department of Agriculture interagency gypsy moth research forum 1991; 1991 January 14-17; Annapolis, MD. Gen. Tech. Rep. NE-167. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 44. Abstract.

Podgwaite, John D.; Reardon, Richard C. 1992. Evaluation of Gypchek applied at low dosage and volume. In: Gottschalk, Kurt W.; Twery, Mark J., eds. Proceedings U.S. Department of Agriculture interagency gypsy moth research forum 1992; 1992 January 13-16; Annapolis, MD. Gen. Tech. Rep. NE-170. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 36. Abstract.

Podgwaite, John D.; Dubois, Normand R.; Reardon, Richard C.; Witcosky, Jeffrey. 1993. Retarding outbreak of low-density gypsy moth (Lepidoptera: Lymantriidae) populations with aerial applications of Gypchek and Bacillus thuringiensis. Journal of Economic Entomology. 86 (3): 730-734.

Podgwaite, John D.; Reardon, Richard C.; Walton, Gerald S.; Witcosky, Jeffrey. 1992. Efficacy of aerially-applied Gypchek against gypsy moth (Lepidoptera: Lymantriidae) in the Appalachian Highlands. Journal of Entomological Science. 27 (4): 337-344.

Cooperative

Webb, Ralph E.; Shapiro, Martin; Podgwaite, John D.; Venables, Lee. 1993. Field conformation of potentiation of a baculovirus by the addition of a stilbene optical brightener. Pesticide Science. 37: 218-219.

Extramural

Burand, J.P.; Horton, H.M.; Elkinton, J.S.; Retnasami, S. 1992. Use of UV irradiation to inactivate gypsy moth viral DNA on the egg surface. In: Gottschalk, Kurt W.; Twery, Mark J., eds. Proceedings U.S. Department of Agriculture interagency gypsy moth research forum 1992; 1992 January 13-16; Annapolis, MD. Gen. Tech. Rep. NE-170. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 10. Abstract.

Burand, J.P.; Park, E.J.; Yin, C.M. 1992. Effect of gypsy moth virus replication on larval development. In: Gottschalk, Kurt W.; Twery, Mark J., eds. Proceedings U.S. Department of Agriculture interagency gypsy moth research forum 1992; 1992 January 13-16; Annapolis, MD. Gen. Tech. Rep. NE-170. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 10. Abstract.

Burand, J.P.; Horton, H.M.; Retnasami, S.; Elkinton, J.S. 1992. The use of polymerase chain reaction and shortwave UV irradiation to detect baculovirus DNA on the surface of gypsy moth eggs. Journal of Virological Methods. 36: 141-150.

Burand, John P.; Park, Eun Ju. 1992. Effect of nuclear polyhedrosis virus infection on the development and pupation of gypsy moth larvae. Journal of Invertebrate Pathology. 60 (2): 171-175.

Dwyer, Greg; Elkinton, Joseph S. 1992. Predicting the within-season dynamics of gypsy moth NPV epizootics. In: Gottschalk, Kurt W.; Twery, Mark J., eds. Proceedings U.S. Department of Agriculture interagency gypsy moth research forum 1992; 1992 January 13-16; Annapolis, MD. Gen. Tech. Rep. NE-170. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 17. Abstract.

Dwyer, Greg; Elkinton, Joseph S. 1992. Using simple models to predict virus epizootics in gypsy moth populations. Journal of animal Ecology. 62: 1-11.

Murray, Kathleen D.; Elkinton, Joseph S. 1992. Vertical distribution of nuclear polyhedrosis virus-infected gypsy moth (Lepidoptera: Lymantriidae) larvae and effects on sampling for estimation of disease prevalence. Journal of Economic Entomology. 85 (5): 1865-1872.

Attainment

The viral pesticide, Gypchek, was shown to be effective in retarding the increase of low-density gypsy moth populations. However, the lack of both a commercial producer and a ready-to-use (RtU) formulation have limited its availability to forest managers. A first generation RtU formulation, developed through collaboration with NOVO NORDISK Inc., performed well in replicated aerial field trials in PA in 1992, and in MI in 1993. Preliminary results indicate that the improved formulation, tested at 40% of the normal dose, was significantly more effective than the standard Gypchek tank mix in reducing the number of larvae and protecting foliage. Reducing the dose increases the number of acre equivalents of Gypchek available for operational programs, reduces the cost per acre, and enhances the marketability of the product by industry. Additionally, ground and aerial tests were conducted in three states in cooperation with ARS scientists using a Gypchek formulation that contains a commercial "brightener" (UV absorbee) and that was provided by American Cyanimid Corp. Ground application of this formulation provided a 10 fold increase in efficacy; results of aerial tests were inconclusive. Because of continued interest in this environmentally safe pesticide, results of Gypchek studies have been reported at various work conferences and scientific meetings, while all available product is being used to treat or eradicate gypsy moth populations in environmentally sensitive areas.

Problem 3 **The effect of Bt application on the distribution and abundance of non-target Lepidoptera**
FY 93 Research Attainments

Publications

Research Unit

McManus, Michael. 1993. New concerns about Bt. In: Souto, Dennis J., comp. Proceedings of the combined meeting of the northeastern forest pest council and the 25th annual northeastern forest insect work conference; 1993 March 8-10; Latham, NY. Syracuse, NY: College of Environmental Science & Forestry, State University of New York: 9.

Peacock, John W.;Schweitzer, Dale F. 1992 Toxicity of Bt to larvae of non-target Lepidoptera in laboratory bioassay. In: Gottschalk, Kurt W.; Twery, Mark J., eds. Proceedings U.S. Department of Agriculture interagency gypsy moth research forum 1992; 1992 January 13-16; Annapolis, MD. Gen. Tech. Rep. NE-170. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 35. Abstract.

Peacock, John W.; Wagner, David L.; Schweitzer, Dale F.; Talley, Steven. 1993. Impacts of Bt on non-target Lepidoptera. In: Souto, Dennis J., comp. Proceedings of the combined meeting of the northeastern forest pest council and the 25th annual northeastern forest insect work conference; 1993 March 8-10; Latham, NY. Syracuse, NY: College of Environmental Science & Forestry, State University of New York: 10-12.

Attainment

Studies continue in the laboratory and field to evaluate the effects of a commercial Bt formulation on larvae of non-target Lepidoptera. Larvae of 41 species have been evaluated to determine their fate following the consumption of Bt-treated foliage in lab bioassays. Larvae were evaluated in the instar in which they occur in the field at the time of a typical Bt application (36BIU/acre). Over 80% of the species evaluated in the early (first or second) instars succumbed to Bt infection, while about 25% of the species evaluated in later instars were affected. There is wide variability in the susceptibility among species and within groups; for example, 10 of 25 Noctuidae species succumbed following ingestion of treated foliage. The results of our bioassays may complicate management decisions involving the widespread use of Bt, particularly where species of "special concern" (threatened, endangered, etc.) exist, since at present, no data are available concerning the susceptibility of any species in this category. These data were reported at several regional insect work conferences, gypsy moth user meetings, and to the Lepidoptera Society of America.

In the field, we have been monitoring ten 50-acre plots – half of which were treated with Bt in May, 1992 in Rockbridge County, VA. Using foliage sampling and collection of larvae of non-target Lepidoptera from under burlap bands, approximately 10,000 larvae were recovered in 1992 and 7,000 larvae in 1993. Comparing the larvae taken in Bt-treated vs. untreated plots, we have recorded an apparent treatment effect among larvae collected in foliage samples during the year of treatment,and among certain species of larvae collected from the burlap samples in the year after application of Bt.

Problem 4 **Introduce/establish exotic pathogens i.e. microsporidia to enhance natural control of GM.**
FY 93 Research Attainments

Publications

Research Unit

Maddox, J.V.; McManus, M.L.; Jeffords, M.R.; Webb, R.E. 1992. Exotic insect pathogens as classical biological control agents with an emphasis on regulatory considerations. In: Kauffman, W.C.; Nichols, J., eds. Proceedings: Selection criteria and ecological consequences of importing natural enemies; 1990; New Orleans, LA. Lanham, MD: Entomological Society of America: 27-39.

McManus, Michael L.; Maddox, Joseph V. 1993. Developing a strategy to use microsporidia against the gypsy moth in forest ecosystems: problems and opportunities. In: Programs and abstracts 26th annual meeting of the Society for Invertebrate Pathology; 1993 August 1-6; Asheville, NC. Raleigh, NC: North Carolina State University: 101. Abstract.

McManus, Michael L. 1993. Integrated Pest Management: A window of opportunity. Journal of Forestry. 1991 (9): 35.

Attainment

Although entomopathogens are important sources of mortality in the population dynamics of insects, few non-indigenous pathogens have been intentionally introduced to enhance the biological control of forest insect pests. The reasons for this oversight were elucidated at a special conference on the selection criteria and ecological consequences of importing natural enemies. Efforts to establish and evaluate the role of an exotic microsporidian pathogen from Eurasian gypsy moth populations are being pursued in Central Michigan. Data were collected from a small scale field release to validate an epizoological model developed by cooperators at the Illinois Natural History Survey. Additionally, laboratory bioassays have been initiated to ascertain the potential effects of this microsporidium on over 20 species of non-target forest Lepidoptera. Foreign explorations for new microsporidian isolates were conducted in both Romania and Central Siberia by work unit scientists in July 1993.

Problem M1 **Develop and evaluate integrated pest management (IPM) strategies to manage the gypsy moth.**
FY 93 Research Attainments

Publications

Research Unit

Carter, J.L.; Ravlin, F.W.; Fleischer, S.J. 1992. Sequential egg mass sample plans for urban habitat. In: Gottschalk, Kurt W.; Twery, Mark J., eds. Proceedings U.S. Department of Agriculture interagency gypsy moth research forum 1992; 1992 January 13-16; Annapolis, MD. Gen. Tech. Rep. NE-170. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 13-14. Abstract.

Cooperative

Carter, M.R.; Ravlin, F.W.; McManus, M.L. 1992. Effect of defoliation on gypsy moth phenology and capture of male moths in pheromone-baited traps. Population Ecology. 21 (6): 1308-1318.

Fleischer, Shelby; Carter, Jane; Reardon, Richard; Ravlin, F. William. 1992. Sequential sampling plans for estimating gypsy moth egg mass density. NA-TP-07-92. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Area, Appalachian Integrated Pest Management. 14 p.

Extramural

Fleischer, Shelby; Roberts, Andy; Young, John; Mahoney, Patricia; Ravlin, F. William; Reardon, Richard. 1992. The development of geographic information system technology for gypsy moth management within a county; an overview. NA-TP-01-93. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Area, Appalachian Integrated Pest Management. 24 p.

Gray, D.R.; Logan, J.A.; Ravlin, F.W. 1992. Modelling gypsy moth egg phenology through a physiological investigation. In: Gottschalk, Kurt W.; Twery, Mark J., eds. Proceedings U.S. Department of Agriculture interagency gypsy moth research forum 1992; 1992 January 13-16; Annapolis, MD. Gen. Tech. Rep. NE-170. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 21-22. Abstract.

Hajek, Ann; Elkinton, Joe S. 1992. Introduction and spread of Entomophaga maimaiga along the gypsy moth leading edge. In: Gottschalk, Kurt W.; Twery, Mark J., eds. Proceedings U.S. Department of Agriculture interagency gypsy moth research forum 1992; 1992 January 13-16; Annapolis, MD. Gen. Tech. Rep. NE-170. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 23. Abstract.

Roberts, E.A.; Ravlin, F.W.; Fleischer, S.J. 1993. Spatial data representation for integrated pest management programs. American Entomologist. 39 (2): 92-107.

Attainment

The gypsy moth is a management challenge to most forest resource managers and to municipalities. The Appalachian Gypsy Moth Integrated Pest Management Project (AIPM) was initiated to demonstrate existing and new approaches to manage this major forest pest. Central to this project was the development of sampling and monitoring systems that could assist managers in making decisions about the need for control of the gypsy moth, the development of automated data processing systems to record and organize data, and production of maps to display information using GIS technology. Consequently, research on the calibration of pheromone-baited traps, development of sequential sampling plans, and utilization of GIS technology was completed and reported in both technology transfer outlets and in scientific journals. However, as the gypsy moth expands its range to the southeast and midwestern states, new challenges and situations will require modification of current recommendations.

Northeastern Forest Experiment Station
Forest Protection Research
Research Work Unit 4503

Impact of Atmospheric Deposition and Global Change on Forest Health and Productivity

Long, Robert P., Project Leader

FY 93 Research Attainments
Research Work Unit Summary

Problem number and title	Functional account	Current funding	Current staffing	Research Outputs		
				Research unit	Extra-mural	Cooper-ative
		thousand dollars	*scientist years*			
1. Effect of atmos. dep. stress/change in global climate on tree growth and other variables	FPR	419	4.4	11		6
2. Deter. effects of atmos. dep. on mature trees and how effects differ from those found in seedlings	FPR	274	2.6	6		

Problem 1 **Effect of atmos. dep. stress/change in global climate on tree growth and other variables**
FY 93 Research Attainments

Publications

Research Unit

Barger, J.H.; Cannon, W.N.; Hall, R.W. 1993 Global climate change and elm leaf beetle performance on "Homestead" elm. The Ohio Journal of Science. 93(2): 13. Abstract.

Cannon, W.N.,Jr.; Barger, J.H.; Hall, R.W. 1993. Influence of foliar nitrogen and water content of CO2 fumigated [CO2 -fumigated] white oak on gypsy moth pupal weight. The Ohio Journal of Science. 93(2): 14. Abstract.

Cannon, William N.,Jr. 1993. Gypsy moth (Lepidoptera: Lymantriidae) consumption and utilization of northern red and white oak foliage exposed to simulated acid rain and ozone. Environmental Entomology. 22 (3): 669-673.

Long, Robert P.; McClenahen, James R. 1993. Effects of insect defoliation on growth and stand dynamics in oak forests of northcentral [north central] Pennsylvania. In: Dendrochronology and dendrochemistry in forest health monitoring – a workshop; 1993 June 25; University Park, PA. [Research Triangle Park, NC]: Environmental Monitoring and Assessment Program - Forests. Abstract. [In cooperation with IUFRO, the U.S. EPA, USFS, and BLM].

Long, Robert P.; McClenahen, James R. 1993. Insect defoliation effects on radial growth of northern red oak in northcentral Pennsylvania. Bulletin of the Ecological Society of America. 74(2) (Suppl.): 336. Abstract.

Long, Robert P. 1992. Maintaining sugarbush health - the Ohio experience. In: Heiligmann, Randall B., ed. Proceedings, 1992 joint meeting of North American Maple Syrup Council, IMSI, OMPA; 1992 October 22-24; Concord, OH. Columbus, OH: The Ohio State University Extension Service: 9-16.

McQuattie, Carolyn J.; Stephenson, Stephen [Steven] L.; Edwards, Pamela J. 1993. Effect of stream acidity on decomposition of sugar maple (Acer saccharum) and red oak (Quercus rubra) leaves. The Ohio Journal of Science. 93(2): 48. Abstract.

McQuattie, Carolyn J.; Schier, George A. 1992. Effect of ozone and aluminum on pitch pine (Pinus rigida) seedlings: anatomy of mycorrhizae. Canadian Journal of Forest Research. 22 (12): 1901-1916.

McQuattie, Carolyn J.; Schier, George A. 1993. Effect of elevated carbon dioxide on changes in growth, cellular structure, and elemental localization in aluminum-treated pitch pine mycorrhizae. In: Peterson, Larry; Schelkle, Michelle, eds. Abstracts of the 9th North American conference on mycorrhizae; 1993 August 8-12; Guelph, ON. [Place of publication unknown]: [Publisher name unknown]. 121. Abstract.

Rebbeck, Joanne; Loats, Ken. 1992. The photosynthetic response of yellow poplar [yellow-poplar] (Liriodendron tulipifera) to two seasons of ozone exposure. In: Tesche, M.; Feller, S., eds. Air pollution and interactions between organisms in forest ecosystems: IUFRO 15th international meeting of specialists in air pollution effects on forest ecosystems: 1992 September 9-11; Tharandt/Dresden, Germany [Vienna, Austria: IUFRO]: 45. Abstract.

Schier, G.A.; McQuattie, C.J. 1993. Effect of elevated carbon dioxide on response of pitch pine to aluminum. In: Joint meeting of Northern and Southern Global Change Programs; 1993 June 8-9; Washington, D.C. [Raleigh, NC]: U.S. Department of Agriculture, Forest Service: 33. Abstract.

Cooperative

Boerner, Ralph E.J.; Rebbeck, Joanne. 1993 Decomposition of hardwood leaves grown under elevated O3 and/or CO2. Bulletin of the Ecological Society of America. 74(2) (Suppl.): 166. Abstract.

Fisher, S.W.; Lydy, M.J.; Barger, J.; Landrum, P.F. 1993. Quantitative structure-activity relationships for predicting the toxicity of pesticides in aquatic systems with sediment. Environmental Toxicology and Chemistry. 12: 1307-1318.

McClenahen, James R.; Long, Robert P. 1993. Height growth of northern red oak in relation to site and atmospheric deposition in Pennsylvania. Environmental Pollution. 80 (2): 105-114.

Percy, K.E.; Jensen, K.F.; McQuattie, C.J. 1992. Effects of ozone and acidic fog on red spruce needle epicuticular wax production, chemical composition, cuticular membrane ultrastructure and needle wettability. New Phytologist. 122: 71-80.

Stephenson, Steven L.; McQuattie, Carolyn J.; Edwards, Pamela J.; Studlar, Susan M. 1992. The effect of acidification on the bryophytes associated with mountain streams. In: Smith, Elizabeth R., ed. Proceedings, 3rd annual southern Appalachian man and the biosphere conference; 1992 November 9-10; Gatlinburg, TN. TVA/LR/NRM/92/2. Norris, TN: Tennessee Valley Authority: 66. Abstract.

Stephenson, Steven L.; Studlar, Susan M.; McQuattie, Carolyn J.; Edwards, Pamela J. 1993. The effects of acidification on the bryophytes associated with West Virginia mountain streams. In: Proceedings of the West Virginia Academy of Science 1993: 65(1) Morgantown, WV: West Virginia Academy of Science, Inc.: 15. Abstract.

Attainment

Research was conducted to evaluate the effects of atmospheric deposition, ozone (O3) and carbon dioxide (C02) on tree growth, leaf and root anatomy, and physiological responses. The interaction of these stresses with other abiotic factors such as soil aluminum (Al) and drought, and biotic stresses (i.e., insect feeding) was also investigated. Studies with red spruce showed O3 (0, 70, 250 ppm) was more damaging than acidic fog (pH 3.0 and 4.2) to needle epicuticular waxes. Other anatomical studies of the effects of O3 (0, 50, 100, 200 ppb) and soil Al (0, 12.5, 25, 50 mg/L) concentrations on pitch pine mycorrhizae indicated that all O3 treatments reduced the percentage of mycorrhizal colonization, while Al reduced colonization only at the highest level. The combined effect of O3 and Al on mycorrhizae anatomical features was greater than the effect of each pollutant alone. A companion study to evaluate CO2 (350 and 700 ppm) and Al effects on pitch pine indicated that roots (biomass, length of laterals) of seedlings grown at 700 ppm CO2 were larger but more sensitive to increasing Al concentrations than roots of seedlings grown in 350 ppm CO2. A two-year study with yellow-poplar showed both leaf age and O3 affected the photosynthetic response of yellow-poplar to light. By mid-season, O3 additions lowered midday photosynthesis of newly expanded leaves by 25% compared to trees grown in a charcoal-filtered chamber. A single season study of the interactions of O3, drought, and ethylenediurea (EDU) treatments on yellow-poplar revealed drought stress reduced net photosynthesis, stomatal conductance, and transpiration by more than 70%, while EDU and O3 had no significant effects. Field studies were initiated to determine the effects of increased O3 and CO2 on elm leaf beetle (ELB) performance on "Homstead" elm.

Problem 2 **Deter. effects of atmos. dep. on mature trees and how effects differ from those found in seedlings**
FY 93 Research Attainments

Publications

Research Unit

Rebbeck, Joanne. 1993. First-year response of yellow-poplar and white pine to elevated carbon dioxide and ozone. In: Joint meeting of Northern and Southern Global Change Programs; 1993 June 8-9; Washington, D.C. [Raleigh, NC]: U.S. Department of Agriculture, Forest Service: 32. Abstract.

Rebbeck, Joanne; Scherzer, Amy J.; Loats, Ken V. 1993. First season effects of elevated CO2 and O3 on yellow poplar [yellow-poplar] and white pine seedlings. Bulletin of the Ecological Society of America. 74(2) (Suppl.): 403-404. Abstract.

Rebbeck, Joanne. 1993. Investigation of long-term effects of ozone and elevated carbon dioxide on eastern forest species: first-year response. In: Air & Waste Management Association: 86th annual meeting & exhibition; 1993 June 13-18; Denver, CO. 93-TA-43.02. [Pittsburgh, PA]: Air & Waste Management Association: 1-10.

Rebbeck, Joanne; Jensen, Keith F.; Greenwood, Michael S. 1993. Ozone effects on grafted mature and juvenile red spruce: photosynthesis, stomatal conductance, and chlorophyll concentration. Canadian Journal of Forest Research. 23 (3): 450-456.

Scherzer, Amy J. 1993. Comparative physiology and morphology of different-sized yellow poplar [yellow-poplar]. Bulletin of the Ecological Society of America. 74(2) (Suppl.): 427. Abstract.

Scherzer, Amy L. [J.]. 1993. Comparisons of the physiology and structure of different-sized yellow poplar [yellow-poplar] (Liriodendron tulipifera L.). The Ohio Journal of Science. 93(2): 48. Abstract.

Attainment

Multiple stresses from atmospheric deposition, global climate change, and other abiotic factors and biotic agents may differentially affect plants depending on their age and stage of development. Most studies have used seedlings, but extrapolation of data from seedlings to mature trees is problematic because of their distinct morphological and physiological differences. Studies are in progress to evaluate the responses of seedlings and mature trees to multiple stresses. A study with grafted mature and juvenile scions of red spruce showed net photosynthesis and stomatal conductance were 38 and 47% higher, respectively, in juvenile than mature scions. Mature and juvenile scions grown for 18 weeks in non-filtered plus 150 ppb O3 showed 29 and 40% reductions, respectively, in mean seasonal net photosynthesis compared with those plants grown in non-filtered air.

First season results of a long-term study with yellow-poplar and eastern white pine revealed that elevated O3 and C02 (300 ppm) had a stimulatory effect on the growth of both species with white pine showing an increase in height growth, while yellow-poplar showed an increase in basal and 1992 terminal-stem diameter. These same trees will be grown in enlarged chambers to evaluate treatment responses over multiple growing seasons.

A field study to compare the physiology and morphology of different-sized yellow-poplar indicated mid-July mean leaf mass and area significantly increased from the lower to upper canopy, although photosynthesis was not affected. Mean leaf area and mass were greatest in seedlings, tending to decrease with increasing diameter.

Northeastern Forest Experiment Station
Forest Protection Research
Research Work Unit 4505

Etiology, Epidemiology and Physiology of Stress-Regulated Host-Pest Interactions
(Stress-Triggered Tree Diseases)
Wargo, Philip M., Project Leader

FY 93 Research Attainments
Research Work Unit Summary

Problem number and title	Functional account	Current funding	Current staffing	Research Outputs		
				Research unit	Extra-mural	Cooper-ative
		thousand dollars	*scientist years*			
1. Role of disease-causing organisms in stress initiated dieback and decline diseases	FPR	382	.8	3		
2. Genetic makeup and pathogenic capabilities of pest populations damaging stressed trees	FPR	92	.3			
3. Better understanding of how forest management practices influence decline diseases	FPR	119	.9			2

Problem 1 **Role of disease-causing organisms in stress initiated dieback and decline diseases**
FY 93 Research Attainments

Publications

Research Unit

Houston, David R. 1992. A host–stress–saprogen model for forest dieback-decline diseases. In: Manion, Paul D; Lachance, Denis, comps., eds. Forest Decline Concepts. St. Paul, MN: APS Press, The American Phytopathological Society: 3-25.

Wargo, P.M.; Bergdahl, D.R.; Tobi, D.R.; Olson, C.W. 1993. Root vitality and decline of red spruce. Contributiones Biologiae Arborum, Vol.4. Landsberg/Lech, Germany: ECOMED Verlagsgesellschaft. 134 p.

Wargo, Philip M.; Onsando, James M. 1992. Armillaria root disease in tea plantations in Kenya. Phytopathology. 82(10): 1151.

Attainment

Continued studies on fine root vitality and acidic deposition were initated in 1992 under the global change program and will focus on the relationship of root biomass, turnover, chemistry, mycorrhizal relationships, and fine root pathology with soil chemistry. Isolations collected last year from dead fine root tips on red spruce has yielded some isolates that are potentially pathogenic on fine roots. Many dematiciaceous fungi were isolated and have been tentatively identified to a group of pseudomycorrhizal fungi. Tomato mosaic virus has been detected using ELISA in roots of healthy and declining mature red spruce. Virus was higher in concentration in trees above cloud base.

Cooperative studies were established to evaluate the interactions of Eutypella canker, sugar maple borer, Armillaria root disease, and stand management in tree decline and their economic and ecological consequences.

Primary trials are now underway to determine if Verticillium lecanii, isolated from diseased pear thrips in VT, is pathogenic to beech scale. Isolates of V. lecanii have been shown to markedly reduce high populations of scale on European beech in Great Britain.

Problem 2 **Genetic makeup and pathogenic capabilities of pest populations damaging stressed trees**
FY 93 Research Attainments

Publications

none

Attainment

Isolations of the Nectria ssp. associated with beech bark disease from stands throughout the range of the disease, and particularly the repeated isolations from stands on the Monongahela National Forest, show that 1) both N. galligena (Ng) and N. coccinea var. faginata (Ncf) can cause "full blown" beach bark disease in conjunction with beech scale; 2) Ng often begins the disease when scale is introduced to stands in advance of the general outbreak and especially in stands that contain high proportions of trees highly susceptible to Ng; 3) Ncf will eventually replace Ng as the pathogen. Stands on the Monongahela National Forest where the disease pathosystem was dominated by Ng, are becoming dominated by Ncf in a manner similar to that which probably occurred earlier in long-affected areas such as eastern Maine.

The taxonomy of Armillaria in mixed oak stands in Pennsylvania, verified in several more plots, shows that distributions of A. gallica may be related to oak species present. More clones occurred in stands with higher proportions of scarlet, white and chestnut oak. A. gallica is the dominant species in these oak stands.

Both topics were presented as posters at the International Phytopathology Congress in Montreal, Canada.

Problem 3 **Better understanding of how forest management practices influence decline diseases**
FY 93 Research Attainments

Publications

Cooperative

Houston, David R. 1992. Effects of paraformaldehyde on sugar maples tapped for sap. I. Survey of damage in some Wisconsin sugarbushes. Phytopathology. 82(10): 1116.

Baker, F.A.; Shaw, C.G.,III; Omdal, D.W.; Wargo, P.M. 1992. Evaluation of the root disease indicator used in the forest health monitoring program. Phytopathology. 82(10): 1152.

Attainment

Armillaria: Mortality after defoliation continued in stands defoliated by the gypsy moth in West Virginia. Measurements will be taken for two more years and related to Armillaria in the stands. Mortality is not related to the abundance of rhizomorphs in the soil but to the number of stumps and snags present in the stand and colonized by Armillaria. The relationship of Armillaria and a competitor, Tricholomopsis platyphylla will be investigated. A series of stands in Pennsylvania and West Virginia with a range of times since thinning were selected and substrate colonization by both fungi were measured during this growing season.

Beech bark disease: The first measurement of sprouting response around cut and standing, resistant and susceptable beech trees following different harvest regemes was made in 12, 10-acre stands in Maine. Total count of beech sprouts and seedlings in 149-15-ft. radius plots were obtained; up to 20 individual sprouts or seedlings in each plot were mapped, measured and tagged. Their fate will be followed for the next two years.

Sugar maple- effects of paraformaldehyde: Fifty-four trees were harvested (the first of three annual harvests) after two growing seasons following treatment with parafomaldehyde. Paraformaldehyde did not influence the incidence of taphole closure, but where cambial dieback did occur, it was greatest around parafomaldehyde tapholes. Significantly more tapholes with treatment had decay but the decay columns were no larger than untreated tapholes. Flushing the tapholes with water when spouts were pulled did not influence decay.

Northeastern Forest Experiment Station
Forest Protection Research
Research Work Unit 4509

Development of Biologically Based Controls for Forest Insect Pests and Diseases Through Molecular Technologies
Slavicek, James M., Project Leader

FY 93 Research Attainments
Research Work Unit Summary

Problem number and title	Functional account	Current funding	Current staffing	Research Outputs: Research unit	Research Outputs: Extra-mural	Research Outputs: Cooperative
		thousand dollars	*scientist years*			
1. Fundamental development of biological agents and biorational approaches for insect control	FPR	848	2.9	11	13	
2. Develop biological and biorational approaches for control of tree diseases	FPR	490	1.8	3		
3. Use of biotechnology to generate solutions to problems supporting current research	FPR	82	.3			

Problem 1 **Fundamental development of biological agents and biorational approaches for insect control**
FY 93 Research Attainments

Publications

Research Unit

Bischoff, David S.; Slavicek, James M. 1993. Sequence characterization and temporal expression of the Lymantria dispar nuclear polyhedrosis virus immediate-early gene IE-I. In: Program and abstracts, Society for Invertebrate Pathology 26th annual meeting, 1993 August 1-6: Asheville, NC. Newark, NJ: Society for Invertebrate Pathology. Abstract #115.

Hayes-Plazolles, Nancy; Mercer, Melissa; Slavicek, James M. 1993. Rapid accumulation of few polyhedra mutants (FP) during serial passage of Lymantria dispar nuclear polyhedrosis virus in L. dispar 652Y cells: Isolation of a viral strain exhibiting resistance to FP mutant formation. In: Program and abstracts, Society for Invertebrate Pathology 26th annual meeting; 1993 August 1-6; Ashville, NC. Newark, NJ: Society for Invertebrate Pathology. Abstract #130.

Koch, Jennifer L.; Valaitis Algimantis P. 1993. Characterization of the digestive proteases of the gypsy moth larvae and the interaction with protease inhibitors. The FASEB Journal. 7(7): A1186. Abstract.

Mercer, Melissa; Slavicek, James M. 1992. Comparison of methods for the generation of recombinant Lymantria dispar nuclear polyhedrosis virus in the 652Y cell line. In: Proceedings U.S. Department of Agriculture interagency gypsy moth research forum 1992: 1992 January 13-16; Annapolis, MD. Gen. Tech. Rep. NE-170. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 61-62. Abstract.

Nagarajan, Maha; Hireinmath, Shiv; Lehtoma, Kirsten. 1992. A recombinant probe representing gypsy moth vitellogen messenger RNA. In Proceedings U.S. Department of Agriculture interagency gypsy moth research forum 1992; 1992 January 13-16; Annapolis, MD. Gen. Tech. Rep. NE-170. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 34. Abstract.

Riegel. Christopher I.; Slavicek, James M. 1993. Characterization of a gene from Lymantria dispar nuclear polyhedrosis virus homologous to the Autographa californica nuclear polyhedrosis virus ecdysteroid UDP-glucosyl transferace gene.. In: Program abstracts, Society for Invertebrate Pathology, 26th annual meeting, 1993 August 1-6: Asheville, NC. Newark, NJ: Society for Invertebrate Pathology. Abstract #114.

Riegel, Christopher I.; Slaviceck, James M. 1993. Cloning and sequencing of a gene from Lymantria dispar nuclear polyhedrosis virus with homology to the Autographa californica nuclear polyhedrosis virus ecdysteroid UDP-glucosyl transferase gene. In: Proceedings U.S. Department of Agriculture interagency gypsy moth research forum 1992; 1992 January 13-16; Annapolis, MD. Gen. Tech. Rep. NE-170. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 62-63. Abstract.

Slavicek, J.M.; Mercer, M., inventors; American Cyanamid Company, assignee. Gypsy moth virus with enhanced polyhedra production stability. U.S. Patent and Trademark Office, Serial No. 08-015961. 1993.

Slavicek, James M. 1992. Enhancement of Lymantria dispar nuclear polyhedrosis virus potency and production in cell culture to facilitate its widespread use for gypsy moth control. In: Proceedings U.S. Department of Agriculture interagency gypsy moth research forum 1992; 1992 January 13-16; Annapolis, MD. Gen. Tech. Rep. NE-170. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 63-64. Abstract.

Valaitis, Algimantas P. 1992. Use of concanavalin A in the purification of juvenile hormone esterase from the hemolymph and fat body of Lymantria dispar. Insect Biochemistry and Molecular Biology. 22 (7): 639-648.

Valaitis, Algimantas P.; Bowers, Diana F. 1993. Purification and properties of the soluable midgut trehalase from recombinant gypsy moth, Lymantria dispar. Insect Biochemistry and Molecular Biology. 23 (5): 599-606.

Extramural

Bonning, B.C.; Hirst, M.; Possee, R.D.; Hammock, B.D. 1992. Further development of a recombinant baculovirus insecticide expressing the enzyme juvenile hormone esterase from Heliothis virescens. Insect Biochemistry and Molecular Biology. 22 (5): 453-458.

Booth, T.F.; Bonning, B,C.; Hammock, B.D. 1992. Localization of juvenile hormone exterase during development in normal and in recombinant baculovirus-infected larvae of the moth Trichoplusia ni. Tissue and Cell. 24 (2): 267-282.

Denlinger, David L.; Lee, Richard E., Jr.; Yocum, George D.; Kukal, Olga. 1992. Role of chilling in the acquisition of cold tolerance and the capacitation to express stress proteins in diapausing pharate larvae of the gypsy moth, Lymantria dispar. Archives of Insect Biochemistry and Physiology. 21: 271-280.

Eldridge, Russ; O'Reilly, David R.; Hammock, Bruce D.; Miller, Lois K. 1992. Insecticidal properties of genetically engineered baculoviruses expressing an insect juvenile hormone esterase gene. Applied and Environmental Microbiology. 58 (5): 1583-1591.

Elkinton, J.S.; Dwyer, G.; Burand, J. 1992. Predicting the spread of engineered virus. In: Proceedings U.S. Department of Agriculture interagency gypsy moth research forum 1992; 1992 January 13-16; Annapolis, MD. Gen. Tech. Rep. NE-170. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 17. Abstract.

Harshman, L.G.; Casas, J.; Dietze, E.C.; Hammock, B.D. 1991. Epoxide hydrolase activities in Drosophila melanogaster. Insect Biochemistry. 21 (8): 887-894.

Harshman, Lawrence G.; Vickers, Joanna M.; Ichinose, Reiji; Grant, David F.; Ward, Vernon K.; Eldridge, Bruce F. 1991. Effects of recombinant juvenile hormone esterase on Aedes aegypti. 1991 Proceedings, California Mosquito Vector Control Association. 59: 77-80.

Ichinose, Reiji; Kamita, Slirizero G.; Maeda, Susumu; Hammock, Bruce D. 1992. Phamacokinetic studies of the recombinant juvenile hormone esterase in Manduca sexta. Pesticide Biochemistry and Physiology. 42: 13-23.

Ichinose, Reiji; Nakamura, Atushi; Yamato, Takaski; Booth, Tim F.; Maeda, Susumu; Hammock, Bruce D. 1992. Uptake of juvenile hormone esterase by pericardial cells of Manduca sexta. Insect Biochemistry and Molecular Biology. 22 (8): 893-904.

Roelvink, P.W.; Van Meer, M.M.M.; de Kort, C.A.D.; Possee, R.D.; Hammock, B.D.; Vlak, J.M. 1992. Dissimilar expression of Autographa californica multiple nucleocaspid nuclear polyhedrosis virus polyhedrin and p10 genes. Journal of general Virology. 73: 1481-1489.

Szekacs, Andros; Bordas, Barna; Hammock, Bruce D. 1992. Transition state analog enzyme inhibitors: structure-activity relationships of triflouromethyl ketones. In: Draber, W.; Fujita, T., comps., eds. Rational approaches to structure, activity, and exotoxicology of agrochemicals. Baca Raton, FL: CRC Press: 219-249.

Ward, Vernon K.; Bonning, Bryony C.; Huang, Tien L.; Shiotsuki, Takahiro; Griffeth, Valerie N.; Hammock, Bruce D. 1992. Analysis of the catalytic mechanism of juvenile hormone esterase by site-directed mutagenesis. International Journal of Biochemistry. 24 (12): 1933-1941.

Wood, H. Alan; Trotter, Karen Munkenbeck; Davis, Thomas R.; Hughes, Patrick R. 1993. Per Os infectivity of preocculated virions from polyhedrin-minus recombinant baculoviruses. Journal of Invertebrate Pathology. 62: 64-67.

Attainment

Juvenile hormone (JH) regulation of vitellogenin (Vg) in the gypsy moth was investigated to understand the mechanism of action of JH in insect's growth, development and reproduction. A recombinant probe (cDNA clone) was constructed, characterized, and used to isolate a putative copy of the gene encoding Vg. The gene sequences will aid isolation and characterization of JH receptors. Gypsy moth midgut proteolytic activity was investigated. A trypsin-like enzyme and type-2 elastase were identified as the major components in gypsy moth midgut lumen along with leucine aminopeptidase an integral membrane protein. Analysis of the interaction of these enzymes with inhibitors may be a key to the success in identifying inhibitors that can be effective for pest control.

The formation of Lymantria dispar nuclear polyhedrosis virus (LdNPV) few polyhedra (FP) mutants during virus propagation in cell culture was investigated. A LdNPV early gene, immediate early I, and the LdNPV ecdysteroid UDP-glucosyl transferase gene were cloned and characterized. A patent was filed on LdNVP strain A21-MVP. This viral strain was provided to the American Cyanamid Company for commercial production trials. Research by cooperators continued on the development of recombinant baculorviruses expressing natural and modified forms of juvenile hormone esterase. The recombinant baculovirus expressing a modified form of JHE exhibited an increased killing speed in comparison to wild type virus.

Problem 2 — Develop biological and biorational approaches for control of tree diseases
FY 93 Research Attainments

Publications

Research Unit

Raghavan, V.; Kamalay, Joseph C. 1993. Expression of two cloned mRNA sequences during development and germination of spores of the sensitive fern Onoclea sensibilis L. Planta. 189: 1-9.

Varley, D.A.; Podila, G.K.; Hiremath, S.T. [1992]. Cutinase gene expression in Cryphonectria parasitica, the chestnut blight fungus: effect of hypovirulence agents on expression. In: Abstracts, international chestnut conference, 1992 July 10-14: Morgantown, WV. [Place of publication unknown]: [Publisher name unknown]: 4.

Varley, D.A.; Podila, G.K.; Hiremath, S.T. 1992. Cutinase in Cryphonectria parasitica, the chestnut blight fungus: Suppression of cutinase gene expression in isogenic hypovirulent strains containing double-stranded RNAs. Molecular and Cellular Biology. 12 (10): 4539-4544.

Attainment

Dutch elm disease research: We are investigating differential gene expression in the DED resistance reaction. Induced resistance genes will be cloned and characterized. PCR amplification of a phytoallexin synthesis gene sequence (sequiterpine cyclase) was completed and sequence comparisons showed differences in resistant and susceptable elms. Examination of gene expression and possible genetic transformation of disease-susceptable elms will allow us to determine its role in disease resistance. A method for protein extraction from elm xylem has been developed, permitting profile comparisons for identification of elm proteins expressed during a defense response. Cuttings from resistant and wild-type American elms have been propagated as test subjects for elicitor trials. An elm callus tissue culture system has been used with HPLC analysis of secondary metabolite extracts to identify in vitro markers correlating the callus/fungus interaction with source tree resistance ratings.

Chestnut blight research: In order to understand molecular basis of pathogenicity of the chestnut blight fungus, Cryphonectria parasitica, expression of several pathogenicity-related genes was investigated using heterologous probes. Cutinase, necessary for penetrating cuticle barriers, was found to be expressed at higher levels in virulent strains than in hypovirulent strains. This and similar information about other genes will be helpful in designing blight control strategies targeted against pathogenicity genes.

Problem 3 **Use of biotechnology to generate solutions to problems supporting current research**
FY 93 Research Attainments

Publications

none

Attainment

Oak wilt disease: Clonal isolates of various oak wilt strains have been developed to facilitate their genetic analysis. DNA extraction methods have been developed permitting efficient processing of oak wilt fungus samples to yield DNA for polymerase chain reactions. Random amplified polymorphic DNA analysis using at least ten random primers have so far revealed few or no differences between a limited group of Delaware strains and strains from Texas, but other isolates are yet to be analyzed.

Beech bark disease: A small sample of trees has been selected for relatedness studies.

Asian gypsy moth research: Studies on the genetic diversity between Asian and European strains of gypsy moth were initiated to develop a nuclear DNA diagnostic assay for identification of gypsy moth field samples. Initial investigations have identified randomly amplified polymorphic DNAs that may be useful for development of a diagnostic assay.

Northeastern Forest Experiment Station
Forest Protection Research
Research Work Unit 4510

Tree Response to Injury and Infection in a Changing Environment
Shortle, Walter C., Project Leader

FY 93 Research Attainments
Research Work Unit Summary

Problem number and title	Functional account	Current funding	Current staffing	Research Outputs: Research unit	Research Outputs: Extra-mural	Research Outputs: Cooperative
		thousand dollars	*scientist years*			
1. Determine magnitude of forest damage attributable to nutrient deficiencies re acid deposition	FPR	181	2.0	1		1
2. Develop dependable early markers for detecting changes in vulnerability of forest trees	FPR	176	1.0	3		

Problem 1 **Determine magnitude of forest damage attributable to nutrient deficiencies re acid deposition**
FY 93 Research Attainments

Publications

Research Unit

Smith, Kevin T. 1993. Helpful and harmful responses to tree treatments. In: Trees for Europe ISA European Congress; 1993 May 2-4; Lahnstein, Germany. Minden/Westfalen, Germany: International Society of Arboriculture: 159-161.

Cooperative

Jellison, Jody; Connolly, Jon; Smith, Kevin; Shortle, Walter. 1993. A comparison of inductively coupled plasma spectroscopy and newtron activation analysis for the determination of cation concentrations in wood. In: The International Research Group on Wood Preservation; 1993 May 16-20; Orlando, FL. IRG/WP/93-10048. Stockholm, Sweden: IRG Secretariat: 9 p.

Attainment

Sample collection and analysis for the first phase of work on this four-year study to better understand the complex relationships among chemical processes taking place in the atmosphere, forest floor, and forest trees is continuing at a rapid rate. New analytical protocols have been developed for analysis of tree-ring tissue and rotting wood. These are currently in the process of being published. Work in integrating the results of cooperating teams of scientists studying various aspects of the same complex system has been initiated, and initial findings will be ready for publication within the next two years. Plans for the second experimental phase of the work to develop remedial actions will be initiated next year. Remedial actions to improve forest floor fertility will be based on recent findings about tree biology and its relationship to root development.

Problem 2 **Develop dependable early markers for detecting changes in vulnerability of forest trees**
FY 93 Research Attainments

Publications

Research Unit

Minocha, Rakesh; Minocha, Subhash C.; Long, Stephanie L.; Shortle, Walter C. 1992. Effects of aluminum on DNA synthesis, cellular polyamines, polyamine biosynthetic enzymes and inorganic ions in cell suspension cultures of a woody plant, Catharanthus roseus. Physiologia Plantarium. 85: 417-424.

Smith, K.T.; Ostrofsky, W.D. 1993. Cambial and internal electrical resistance of red spruce trees in eight diverse stands in the northeastern United States. Canadian Journal of Forest Research. 23 (2): 322-326.

Smith, K.T.; Shortle, W.C. 1993. Compartmentalization response of two clones of hybrid-poplar. European Journal of Forest Pathology. 23: 11-17.

Attainment

Work on detecting changes in the growth rate of mature red spruce trees and the spread of internal infections by electrical methods has been published. Early detection of adverse changes in tree productivity and health is useful for determining the risk of forest damage and for applying remedial actions. Work on biochemical markers of adverse effects of aluminum on cellular processes of forest plants was also published. A better understanding of the genetically inherited mechanisms of tree response to injury and infection and molecular regulation of growth and defense processes has potential for evaluating vulnerability factors in complex forest ecosystems. Progress toward the goal of developing early markers of changes in the vulnerability of forest trees to environmental change is being made.

Northeastern Forest Experiment Station
Forest Protection Research
Research Work Unit 4557

Silvicultural Options for the Gypsy Moth
Gottschalk, Kurt W., Project Leader

FY 93 Research Attainments
Research Work Unit Summary

Problem number and title	Functional account	Current funding	Current staffing	Research Outputs		
				Research unit	Extra-mural	Cooper-ative
		thousand dollars	*scientist years*			
1. Effects of damage by the gypsy moth and its associated organisms in various types of stands	FPR	420	1.1	3	4	1
2. Silvicultural practices in reducing damage to forest stands by the gypsy moth	FPR	340	1.0	2		
3. Develop and evaluate decision-making systems to manage the gypsy moth	FPR	619	2.1	7	2	4
4. Northeast Decision Model Development	FMR	793	.7	1		
5. Global Change Program	FPHR	199	2.1			
6. Miscellaneous topics	FPR	0	.0	5		4

Problem 1 **Effects of damage by the gypsy moth and its associated organisms in various types of stands**
FY 93 Research Attainments

Publications

Research Unit

Barrett, Hope R.; Nodvin, Stephen C. 1993. Using GIS to assess potential impacts of gypsy moth infestations at Great Smoky Mountains NP. Park Science. 13(2): 26-27.

Barrett, Hope R.; Nodvin, Stephen C. 1993. Assessment of potential impact of gypsy moths on Great Smoky Mountains National Park. In: Liebhold, Andrew M.; Barrett, Hope R., eds.; 1992 April 27-30; Mountain Lakes, VA. Gen. Tech. Rep. NE-175. Radnor, PA: U.S.Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 73-84.

(This work was funded by the National Park Service, Cooperative Park Studies Unit.)

Muzika, R.M. 1993. Understanding the ecological effects of gypsy moth. Gypsy Moth News. Morgantown, WV: U.S. Department of Agriculture, Forest Service, Northeastern Area. 32: 7-9.

Cooperative

Hollenhorst, Steven J.; Brock, Samuel M.; Friemund, Wayne A.; Twery, Mark J. 1993. Predicting the effects of gypsy moth on near-view aesthetic preferences and recreation appeal. Forest Science. 39 (1): 28-40.

(This work was funded under a cooperative agreement with West Virginia University by the Gypsy Moth Research and Development Program.)

Extramural

Butler, Linda. 1992. The community of macrolepidopterous larvae at Cooper's Rock State Forest, West Virginia: a baseline study. The Canadian Entomologist. 124: 1149-1156.

(This work was funded under a cooperative agreement with West Virginia University by the Gypsy Moth Research and Development Program.)

Byington, Timothy Scott. 1992. Natural selection and potential for evolution in red oaks (Quercus rubra L.) populations subjected to gypsy moth (Lymantria dispar L.) defoliation. Morgantown, WV: West Virginia University. 104 p. M.S. thesis.

(Funding provided under cooperative agreement with West Virginia University by the Gypsy Moth Research and Development Program.)

Hutta, Paul. 1993. Factors influencing public attitudes toward gypsy moth suppression. Morgantown, WV: West Virginia State University. 115 p. M.S. thesis.

(Funding provided by a cooperative agreement with West Virginia University by the Gypsy Moth Research and Development Program.)

Thurber, Dale King. 1992. Impacts of a gypsy moth outbreak on bird habitats and populations. Morgantown, WV: West Virginia University. 258 p. Ph.D. dissertation.

(This work was funded under a cooperative agreement with West Virginia University by the Gypsy Moth Research and Development Program.)

Attainment

Research on the effects of gypsy moth on forest ecosystems and socio-economic factors have resulted in the completion of two Master's Theses and one Ph.D dissertation in these areas. In particular, the knowledge on social aspects of gypsy moth has been substantially increased by developing methods to predict gypsy moth effects on near view aesthetic preferences of forest users and on the recreation appeal of forested areas that have suffered varying degrees of mortality following gypsy moth defoliation. This information will provide managers' increased ability to decide on the need for gypsy moth control treatments to prevent unacceptable social effects. This work lead directly to the MS Thesis work on assessing what factors influence public attitudes toward gypsy moth and suppression treatments for gypsy moth.

Managers can use both studies to weigh the negatives of gypsy moth effects on recreational appeal versus the negatives of attitudes about suppression treatments to arrive at management actions that minimize conflict and maximize resource protection.

Other work has continued on previous work projecting impacts and new examination of the potential genetic shifts in oaks due to gypsy moth selection pressures and potential changes in biodiversity.

Problem 2 **Silvicultural practices in reducing damage to forest stands by the gypsy moth**
FY 93 Research Attainments

Publications

Research Unit

Gottschalk, Kurt W. 1993. Silvicultural guidelines for forest stands threatened by the gypsy moth. Gen. Tech. Rep. NE-171. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 49 p.

Gottschalk, Kurt W.; MacFarlane, W. Russ. 1993. Photographic guide to crown condition of oaks: use for gypsy moth silvicultural treatments. Gen. Tech. Rep. NE-168. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 8 p.

Attainment

Recent research results have been incorporated in the revision of silvicultural guidelines to minimize gypsy moth effects on forest stands. The guidelines include decision charts for managers to use in deciding what treatments to use based on forest stand and insect conditions. In addition to the guidelines, descriptions of treatments including marking guides and background information on gypsy moth-forest interactions are included.

A companion photographic guide to crown condition of oaks is available to help managers develop marking priorities for applying silvicultural treatments. Several training sessions and field tours on the use of silvicultural treatments to minimize gypsy moth effects have been conducted. Over 2000 copies of these publications have been distributed to the National Forest System, State, Industry, and consulting foresters and forest managers. Requests for training sessions and tours of demonstration areas continue as well.

Problem 3 **Develop and evaluate decision-making systems to manage the gypsy moth**
FY 93 Research Attainments

Publications

Research Unit

Colbert, J.J. 1992. Effects of the gypsy moth life system on growth and yield of mixed hardwood stands. In: Teller, A.; Mathy, P.; Jeffers, J.N.R., comps., eds. Proceedings: Responses of forest ecosystems to environmental changes. New York, NY: Elsevier Applied Science: 961-962.

(Proceedings published as a book.)

Liebhold, Andrew; Hohn, Michael E.; Gribko, Linda S. 1993. Forecasting the spatial dynamics of gypsy moth defoliation using 3-dimensional kriging. In: Liebhold, Andrew M., Barrett, Hope R., eds. Proceedings: Spatial analysis and forest pest management; 1992 April 27-30; Mountain Lakes, VA. Gen. Tech. Rep. NE-175. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 150-159.

Liebhold, Andrew; Luzader, Eugene; Halverson, Joel; Elmes, Gregory. 1993. The spatial dynamics of invasions by exotic forest pests. In: Liebhold, Andrew M., Barrett, Hope R., eds. Proceedings: Spatial analysis and forest pest management; 1992 April 27-30; Mountain Lakes, VA. Gen. Tech. Rep. NE-175. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 125-132.

Liebhold, Andrew M.; Barrett, Hope R. 1993. Proceedings: Spatial analysis and forest pest management. In: Liebhold, Andrew M.; Barrett, Hope R., eds.; 1992 April 27-30; Mountain Lakes, VA. Gen. Tech Rep. NE-175. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 186 p.

Liebhold, Andrew M.; Halverson, Joel A.; Elmes, Gregory A. 1992. Gypsy moth invasion in North America: a quantitative analysis. Journal of Biogeography. 19: 513-520.

Liebhold, Andrew M.; Simons, Edward E.; Sior, Alan; Unger, James D. 1993. Forecasting defoliation by the gypsy moth from field measurements. Environmental Entomology. 22 (1): 26-32.

Twery, M.J.; Elmes, G.A.; Schaub, L.P.; Foster, M.A.; Saunders, M.C. 1993. GypsES: a decision support system for gypsy moth management. In: Liebhold, Andrew M.; Barrett, Hope R., eds. Proceedings: Spatial analysis and forest pest management; 1992 April 27-30; Mountain Lakes, VA. Gen. Tech. Rep. NE-175. Radnor, Pa: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 56-64.

(This work was partially funded by the Forest Pest Management Special Projects Fund.)

Cooperative

Allen, J.C.; Foltz, J.L.; Dixon, W.N.; Lieghold, A.M.; Colbert, J.J.; Regniere, J. 1993. Will the gypsy moth become a pest in Florida? Florida Entomologist. 76 (1): 102-113.

Elmes, Gregory A.; Liebhold, Andrew M.; Twery, Mark J. 1993. Two approaches to landscape characterization of susceptability to gypsy moth defoliation. In: Liebhold, Andrew M.; Barrett, Hope R., eds. Proceedings: Spatial analysis and forest pest management; 1992 April 27-30; Mountain Lakes, VA. Gen. Tech. Rep. NE-175. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 172-183.

Hohn, Michael E.; Gribko, Linda S.; Liebhold, Andrew M. 1993. Forecasting gypsy moth defoliation with indicator kriging. In: Soares, A., ed. Geostatistics Troid '92; Dordrecht, Netherlands. [Place of publ. unknown]: Kluwer Academic Publishers: 601-612.

(Proceedings published as a hard cover book.)

Russo, Joseph M.; Liebhold, Andrew M.; Kelley, John G.W. 1993. Mesoscale weather data as input to a gypsy moth (Lepidoptera: Lymantriidae) phenology model. Journal of Economic Entomology. 86 (3): 838-844.

(This work was funded under a cooperative agreement with ZedX, Inc. by the Gypsy Moth Research and Development Program.)

Extramural

Butler, Linda. 1993. Parasitoids associated with the macrolepidoptera community at Cooper's Rock State Forest, West Virginia: a baseline study. Proceedings of the Entomological Society of Washington. 95 (3): 504-510.

Foster, Michael A.; Saunders, M.C.; Ramirez, M.; Duan, N.; Miller, B.J. 1992. The treatment advisor in gypsES: An object oriented, knowledge based system for gypsy moth management. The Compiler. 10 (3): 35-46.

(This work was funded under a cooperative agreement with Pennsylvania State University by the Gypsy Moth Research and Development Program and the Forest Pest Management Special Projects Fund.)

Attainment

Geostatistical modeling of gypsy moth dynamics has resulted in the development of a quantitative spread model for gypsy moth. This model is being used to predict the time of arrival of gypsy moth into uninfested areas by forest pest managers. It can also be used to test the effectiveness of management programs to slow the spread of gypsy moth. Predicting gypsy moth development as a tool for timing suppression treatments was aided by the development of mesocale climatological data for landscape level predictions of development using the gypsy moth phenology model. Forecasting of gypsy moth defoliation as a decision making factor to pest managers has been improved with analysis at two scales: the stand-level predicting defoliation from egg-mass counts and the landscape level predicting defoliation from previous defoliations. Simulation modeling of population dynamics was used to determine if gypsy moth would become established in Florida and the potential for it to become a pest. Work of GypsES, the gypsy moth expert system, has progressed with the software being beta-tested at two field sites. Feedback from the test sites is being used to incorporate changes into the system. This multi-faceted approach to modeling is developing tools that can be used by pest managers, forest managers, and researchers to further the transfer of our knowledge base to users.

Problem 4	Northeast Decision Model Development FY 93 Research Attainments

Publications

Research Unit

Twery, Mark J. 1993. Review: Silvicultural systems. The Quarterly Review of Biology. 68 (3): 453-454.

Attainment

Development of the Northeast Decision Model (NED) continued. The previously released test version of the Stand Inventory Processor and Simulator (NED/SIPS) has been reviewed and extensively revised and improved. This software package is being used by foresters across the Northeast for summerization and simulation of forest stand data and future projections of growth. The goals interview program associated with NED has been released for initial testing. Extensive use of the Interview Program is expected among consulting foresters, landowners, and students interested in the conflicts and trade-offs among resource values. This system is designed for use by the National Forests in project planning and by consulting foresters in decision planning for private landowners. The significance of these accomplishments are that they represent the delivery of a comprehensive system for analyzing forested ecosystems and the effects that management decisions may have on those systems. The accomplishments further represent the synthesis of large amounts of previously inaccessible scientific information into a highly accessible form of technology transfer. This transfer occurred through group meetings with current and potential user groups and their representatives, plus distribution of these versions of the software under development.

Problem 5	Global Change Program FY 93 Research Attainments

Publications

none

Attainment

A draft plan for the management of long-term data sets valuable for global change research has been developed. A catalog of data sets that are available for use is under preparation.

Progress is also being made toward the basic system for analyzing the output from global circulation model scenarios by the analysis of time-series of insect populations against weather summaries from two different areas.

Problem 6 — Miscellaneous topics
FY 93 Research Attainments

Publications

Research Unit

Gottschalk, Kurt W.; Twery, Mark J. 1992. Proceedings: U.S. Department of Agriculture interagency gypsy moth research forum 1991. In: Proceedings: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1991 January 14-17; Annapolis, MD. Gen. Tech. Rep. NE-167. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 54 p.

Gottschalk, Kurt W.; Twery, Mark J. 1992. Proceedings: U.S. Department of Agriculture interagency gypsy moth research forum 1992. In: Gottschalk, Kurt W.; Twery, Mark J., eds.; 1992 January 13-16; Annapolis, MD. Gen. Tech. Rep. NE-170. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 60 p.

Liebhold, Andrew M.; Rossi, Richard E.; Kemp, William P. 1993. Geostatistics and geographic information systems in applied insect ecology. Annual Review of Entomology. 38: 303-327.

Muzika, R.M; Pregitzer, K.S. 1992. Effect of nitrogen fertilization on leaf phenolic production of grand fir seedlings. Trees. 6: 241-244.

Williams, D.W.; Fuester, R.W.; Metterhouse, W.W.; Ballam, R.J.; Bullock, R.H.; Chianese, R.J. 1993. Incidence and ecological relationships of pupal parasitism by Brachymeria intermedia (NEES) in New Jersey populations of the gypsy moth. Entomophaga. 38 (2): 217-226.

(This work was conducted while the senior author was with USDA Agricultural Research Service.)

Cooperative

Cutler, Bruce; Jennings, Daniel T. 1992. Habitat segregation by species of Metaphidippus (Araneae: Salticidae) in Minnesota. Journal of Arachnology. 20: 88-93.

Horsley, Stephen B.; Gottschalk, Kurt W. 1993. Leaf area and net photosynthesis during development of Prunus serotina seedlings. Tree Physiology. 12: 55-69.

Lewinsohn, Efraim; Gijzen, Mark; Muzika, Rose Marie; Barton, Keith; Croteau, Rodney. 1993. Oleoresinosis in grand fir (Abies grandis) saplings and mature trees: modulation of this wound response by light and water stresses. Plant Physiology. 101: 1021-1028.

Muzika, Rose Marie; Engle, Judith; Parks, Catherine; Wickman, Boyd. 1993. Variation in phenology and monoterpene patterns of defoliated and non-defoliated Douglas Fir (Pseudotsuga menziesii var. glauca). Res. Pap. PNW-RP-459. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 10 p.

Attainment

Contributions by unit scientists in the areas of host foliage-insect interactions, chemical ecology, parasite dynamics, geostatistics, and editing of U. S. Department of Agriculture gypsy moth research have expanded the general knowledge base of forest insect biology.

Northeastern Forest Experiment Station
Forest Products and Harvesting Research
Research Work Unit 4701

Improved Processing Technology for Hardwoods
Brisbin, Robert L., Project Leader

FY 93 Research Attainments
Research Work Unit Summary

Problem number and title	Functional account	Current funding	Current staffing	Research Outputs		
				Research unit	Extra-mural	Cooper-ative
		thousand dollars	*scientist years*			
1. Need to develop techniques to evaluate production /economic implications using new processing	FPHR	572	2.5	6	1	1
2. Procedures and test criteria needed for evaluating CNC machinery and tooling	FPHR	485	2.0	5		3
3. Techniques needed to make existing information available to decision makers	FPHR	168	.5	1		

Problem 1 **Need to develop techniques to evaluate production /economic implications using new processing**
FY 93 Research Attainments

Publications

Research Unit

Gatchell, Charles; Klinkhachorn, Powsiri; Kothari, Ravi. 1992. ReGS – a realistic grading system. Forest Products Journal. 42 (10): 37-40.

Gatchell, Charles J. 1993. Do-it-yourself gang-rip-first analysis for red oak lumber. In: Forest Products Society 47th annual meeting: bibliographies and abstracts; 1993 June 20-23; Clearwater Beach, FL. Madison, WI: Forest Products Society: 35. Abstract.

(Plenary session presentation. Abstract printed in meeting agenda.)

Gatchell, Charles J. 1992. Increasing yields from lower grade lumber. Woodshop News. 6 (12): 24-25.

Gatchell, Charles J.; Wiedenbeck, Janice K.; Walker, Elizabeth S. 1992. 1992 data bank for red oak lumber. Res. Pap. NE-669. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 47 p.

Gatchell, Charles J.; Wiedenbeck, Janice K.; Walker, Elizabeth S. 1993. A red oak data bank for computer simulations of secondary processing. Forest Products Journal. 43 (6): 38-42.

Hoff, Kristen G. 1993. Computer integrated production planning tool for secondary wood processing industry. In: Technologies for competitive growth in West Virginia; 1992 October 28; Shepherdstown, WV. Morgantown, WV: The Software Valley Foundation: 13-15.

Cooperative

Klinkhachorn, Powsiri; Gatchell, Charles; McMillin, Charles; Kothari, Ravi; Yost, Dennis. 1992. HaLT 2 – an enhanced lumber grading trainer. Forest Products Journal. 42 (10): 32-36.

Extramural

Patterson, David W.; Armstrong, James P. 1993. Factors affecting the value of moulded products from yellow-poplar lumber. Forest Products Journal. 43 (6): 25-28.

(Work conducted through a formal cooperative agreement with West Virginia University.)

Attainment

An extensive data bank for red oak lumber that is compatible with most secondary manufacturing computer simulation tools has been developed. Currently, the data bank contains about 11,000 board feet, or 1,600 boards, in the grades of FAS, Select, No. 1 Common, and No. 2A Common. This lumber was selected from several sawmills over a period of several years and was digitized to record board dimensions and all defects. The boards were graded by the National Hardwood Lumber Association's Special Kiln Dried Rule as implemented by the computerized grading system called ReGS. The percentage of a board's surface measure contained in clear-face cuttings of required sizes can vary considerably depending on whether the board is graded by a human or a computer. Both computer-generated minimum percentages and human-generated optimum clear-faced percentages are included in the data bank. The availability of this data bank should provide users with confidence that differences between their findings and those of others are attributable to differences in the process being simulated and not in the raw material samples. The board data bank is used by RWU researchers to study the effects of gang ripping technology on dimension yields of lower grade lumber. It is also used by other researchers to study alternative processing options and by wood processing companies to simulate production processes and examine alternatives before investing in expensive changes to their production lines.

Problem 2 — Procedures and test criteria needed for evaluating CNC machinery and tooling
FY 93 Research Attainments

Publications

Research Unit

Adams, Edward L. 1993. CAD/CAM in the furniture industry. In: Yeh, M.C.; Wang, H.H.: Chiang, C.L., eds. Proceedings, knowledge based expert system for the furniture industry; 1992 November 2-6; Pingtung, Taiwan. [Place of publ. unknown]: [Publisher name unknown]: 3-1 - 3-13.

(In cooperation with IUFRO, Project Group P5.08)

Adams, Edward L.; Rast, Everette D. 1993. Evaluation procedure for CNC woodworking machinery. In: Technologies for competitive growth in West Virginia; 1992 October 28; Shepherdstown, WV. Morgantown, WV: The Software Valley Foundation: 11-12.

Anderson, R. Bruce. 1993. Forest products industry equipment investment evaluated using computer software. In: Forest Products Society 47th annual meeting: bibliographies and abstracts; 1993 June 20-23; Clearwater Beach, FL. Madison, WI: Forest Products Society: 22-23. Abstract.

(Plenary session presentation. Abstract printed in meeting agenda.)

Anderson, R. Bruce; Patterson, David W.; Zhang, Libo. 1993. Application of statistical process control to automated woodworking machinery. In: Forest Products Society 47th annual meeting: bibliographies and abstracts; 1993 June 20-23; Clearwater Beach, FL. Madison, WI: Forest Products Society: 13-14. Abstract.

(Plenary session presentation. Abstract printed in meeting agenda.)

Anderson, R. Bruce; Thomas, R. Edward; Gatchell, Charles J.; Bennett, Neal D. 1993. Computerized technique for recording board defect data. Res. Pap. NE-671. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 17 p.

Cooperative

Conners, Richard W.; Cho, Tai-Hoon; Ng, Chong T.; Drayer, Thomas H.; Araman, Philip A.; Brisbin, Robert L. 1992. A machine vision system for automatically grading hardwood lumber. Industrial Metrology. 2 (3/4): 317-342.

Conners, Richard W.; Kline, D. Earl; Araman, Philip A.; Brisbin, Robert L. 1993. Reflections on the development of a machine vision technology for the forest products industry. In: Yeh, M.C.; Wang, H.H.; Chiang, C.L., eds. Proceedings, knowledge based expert system for the furniture industry; 1992 November 2-6; Pingtung, Taiwan. [Place of publ. unknown]: [Publisher name unknown]: 6-1 - 6-20.

(In cooperation with IUFRO, Project Group P5.08)

Zhang, Libo; Patterson, David W.; Anderson, R. Bruce. 1993. Use of statistical process control in the furniture and cabinet industries. In: Forest Products Society 47th annual meeting: bibliographies and abstracts; 1993 June 20-23; Clearwater Beach, FL. Madison, WI: Forest Products Society: 40. Abstract.

Attainment

As the wood processing industry moves toward more automated processing systems, several technologies must be integrated before the industry can realize the maximum benefits. RWU and other cooperating scientists are working with several of these technologies, including automated machine vision, statistical process control, computer aided design/computer aided manufacturing (CAD/CAM) software, and computer numerically controlled (CNC) machinery evaluation.

Machine vision technology has many applications beyond just locating defects in raw material. For example, it can be coupled with statistical process control techniques and automated processing machines to better control and monitor end product quality. Statistical process control technologies can be used to monitor the entire production process with or without automated processing machinery, allowing these technologies to be adapted to very small plants as well as larger ones. CAD/CAM technology can also be effectively used by small custom manufacturers as well as large furniture companies.

Problem 3 — Techniques needed to make existing information available to decision makers
FY 93 Research Attainments

Publications

Research Unit

Sonderman, David L.; Brisbin, Robert L. 1993. Directory of training programs for the woodworking industry. Gen. Tech Rep. NE-173. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 33 p.

Attainment

RWU personnel continue to develop and maintain on-line relational databases of information that can be accessed interactively to quickly answer questions from industrial managers and technical personnel. New information added to the databases this year includes manufacturers of semi-finished wood parts and specialty items. For example, the database includes manufacturers of cabinet doors and other components that can be purchased by cabinet manufacturers.

Previously available information includes woodworking machinery manufacturers, dealers, and machinery descriptions with an emphasis on computer controlled machinery; basic statistics and analysis of hardwood product import and export trade data; and sources of woodworker training for the newer technologies.

Exhibits of RWU research were presented at seven industry trade shows and professional meetings. Thirteen oral presentations were made at industrial and professional meetings and about 800 individual inquiries were answered during the year. About 60 percent of the inquiries came from the wood-using industry and the remainder were from other researchers, state organizations, rural development commissions, and consultants. About 40 percent of the inquiries related to economics and hardwood trade statistics; 35 percent concerned wood processing machinery and wood technology; and the remainder concerned woodworker training and sources of supply for wood products.

Northeastern Forest Experiment Station
Forest Products and Harvesting Research
Research Work Unit 4702

Forest Engineering Research–Timber Harvesting Systems and Equipment for Steep Terrain
Peters, Penn A., Project Leader

FY 93 Research Attainments
Research Work Unit Summary

Problem number and title	Functional account	Current funding	Current staffing	Research Outputs		
				Research unit	Extra-mural	Cooper-ative
		thousand dollars	*scientist years*			
1. Feasibility of non-conventional approaches to tree cutting and removal on fragile sites	FPHR	0	.0			
2. Methods to reduce safety risks and related costs which characterize the wood harvesting industry	FPHR	150	1.0	3		

Problem 1	**Feasibility of non-conventional approaches to tree cutting and removal on fragile sites** **FY 93 Research Attainments**

Publications

none

Attainment

There was no progress made towards solutions for this problem during FY93.

Problem 2 — Methods to reduce safety risks and related costs which characterize the wood harvesting industry
FY 93 Research Attainments

Publications

Research Unit

Peters, Penn. 1993. Logging safety: recent research in directional felling. In: 21st annual hardwood symposium of the Hardwood Research Council; 1993 May 24-26; Cashiers, NC. Memphis, TN: Hardwood Research Council: 73-78.

Peters, Penn A. 1992. Research on mechanical hazards, a forestry perspective. In: Papers and proceedings of the Surgeon General's conference on agricultural safety and health – 1991. NIOSH Publ. 92-105. Cincinnati, OH: National Institute for Occupational Safety and Health: 317-320.

Peters, Penn A. 1992. The effects of stand geometry on felling hazards. ASAE Pap. 927507. St. Joseph, MI: American Society of Agricultural Engineers. 9 p.

Attainment

Chainsaw felling hardwood trees in a partial cut is the most dangerous activity in logging. However, the feller can make the workplace safer by selecting a safe direction of fall, controlling the direction of fall by utilizing good felling technique, recognizing potentially hazardous felled tree/hit tree reactions, and retreating quickly on a planned escape route as the tree falls. The feller can also change the order in which trees are felled to improve safety.

The following rule for selecting a safe direction of fall is a result of FY93 research: if the crown of the hit tree is wider than the crown of the felled tree, aim the bole of the felled tree at the edge of the crown of the hit tree or beyond; otherwise, aim the edge of the crown of the felled tree at the bole of the hit tree or beyond. If this simple rule were observed, approximately 40 lives could be saved and thousands of injuries could be prevented annually.

Northeastern Forest Experiment Station
Forest Products and Harvesting Research
Research Work Unit 4751

Systems to Integrate Harvesting With Other Resource Management Objectives
LeDoux, Chris, Project Leader

FY 93 Research Attainments
Research Work Unit Summary

Problem number and title	Functional account	Current funding	Current staffing	Research Outputs		
				Research unit	Extra-mural	Cooper-ative
		thousand dollars	*scientist years*			
1. Inadequate forest management planning tools for steep terrain	FPHR	200	1.0	2		1
2. Inadequate methods to plan/carry out multiproduct harvest/util. of E. hardwood on steep terrain	FPHR	200	1.0	1		

Problem 1 **Inadequate forest management planning tools for steep terrain**
FY 93 Research Attainments

Publications

Research Unit

Baumgras, J.E.; LeDoux, C.B. 1993. Software to estimate timber harvesting cost and revenue for Eastern hardwoods. In: American forestry – an evolving tradition: Proceedings of the 1992 Society of American Foresters; 1992 October 25-28; Richmond, VA. SAF Publ. 92-01. Bethesda, MD: Society of American Foresters: 573-574.

Baumgras, John E.; LeDoux, Chris B. 1992. Computer software to estimate timber harvesting system production, cost, and revenue. The Compiler. 10 (4): 28-32.

Cooperative

Erickson, Michael D.; Hassler, Curt C.; LeDoux, Chris B. 1992. Economic comparisons of haul road construction versus forwarding versus longer skid distances. ASAE Pap. 92-7513. St. Joseph, MI: American Society of Agricultural Engineers. 19 p.

Attainment

A publication describing computer software for estimating harvesting cash flows provides the forest industry and forest land managers with information and technology required to identify economically feasible timber harvesting opportunities, select appropriate harvesting technology, and determine the potential cost of modifying harvesting practices to reduce environmental impacts. Cost and production information was developed to make decisions about harvesting units of different sizes with ground-based logging systems. Prediction equations were developed to estimate skidding costs for group-selection units ranging in size from 0.5 to 2.0 acres. Results show that when group-selection harvests result in very small and scattered harvest units that require frequent moves between units, then the cost to move in and out of each unit can become prohibitive. Three methods of timber extraction, including constructing truck haul roads, skidding longer distances, and forwarding timber were examined. The results of this investigation along with other research can be refined, over time, to reflect a more comprehensive set of variables, conditions and constraints from which to base further guidelines and recommendations on the most efficient and cost effective harvesting technique to utilize. Results of this research have been presented to resource managers, policy makers and other researchers through publications, symposia, and other appropriate outlets.

Problem 2 **Inadequate methods to plan/carry out multiproduct harvest/util. of E. hardwood on steep terrain**
FY 93 Research Attainments

Publications

Research Unit

Baumgras, John E. 1992. Effects of silvicultural prescriptions and roundwood markets on the economic feasibility of hardwood thinnings. In: Proceedings, 20th annual hardwood symposium of the Hardwood Research Council; 1992 June 1-3; Cashiers, NC. Memphis, TN: Hardwood Research Council: 131-142.

Attainment

Forest growth and timber harvesting simulations were applied to determine the effects of silvicultural prescriptions and roundwood markets on the economic feasibility of thinning upland oak stands. Results published and presented at a symposium demonstrate the significant impacts of stand age at thinning and thinning intensity on harvesting costs, multiproduct yields, and net cash flow. The results indicate that variable roundwood markets can postpone commercial thinning 10 to 20 years, or eliminating thinning as a management option. The analysis of roundwood harvesting and marketing options also shows the importance of multiproduct harvesting to generate cash flows required for commercial thinning. A presentation and publication describing 17-year trends in the deflated prices of hardwood stumpage, logs, and lumber in Ohio, indicate that transferred efficiencies in milling and harvesting have resulted in stumpage price increases that exceed those for delivered sawlogs or lumber.

Northeastern Forest Experiment Station
Resource Analysis Research
Research Work Unit 4801

Forest Inventory and Analysis
Peters, John R., Project Leader

FY 93 Research Attainments
Research Work Unit Summary

Problem number and title	Functional account	Current funding	Current staffing	Research Outputs: Research unit	Research Outputs: Extra-mural	Research Outputs: Cooperative
		thousand dollars	*scientist years*			
1. Conduct periodic forest resources inventories and evaluations	RAR	2226	.0	3	1	3
2. Conducting special analyses of specific resource issues and concerns	RAR	856	2.0	8		3

Problem 1 **Conduct periodic forest resources inventories and evaluations**
FY 93 Research Attainments

Publications

Research Unit

Alerich, Carol L. 1993. Forest statistics for Pennsylvania –1978 and 1989. Resour. Bull. NE-126. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 244 p.

Griffith, Douglas M.; DiGiovanni, Dawn M.; Witzel, Teresa L.; Wharton, Eric H. 1993. Forest statistics for Ohio, 1991. Resour. Bull. NE-128. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 169 p.

Wharton, Eric H.; Mullarkey, Kevin. 1993. Forest products industries of the southern Middle-Atlantic states, 1985-1986. Resour. Bull. NE-129. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 40 p.

Cooperative

Brooks, Robert T.; Kittredge, David B.; Alerich, Carol L. 1993. Forest resources of southern New England. Resour. Bull. NE-127. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 71 p.

Hackett, Ronald L.; Widmann, Richard H. 1993. Pulpwood production bounces back in Northeast and Lake States in 1991. Northern Logger. 41 (11): 14-15.

Hansen, Mark H.; Frieswyk, Thomas; Glover, Joseph F.; Kelly, John F. 1992. The Eastwide forest inventory data base: users manual. Gen. Tech. Rep. NC-151. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. 48 p.

Extramural

Eagar, Christopher; Miller-Weeks, Margaret; Gillespie, Andrew J.R.; Burkmann, William. 1992. Summary report: forest health monitoring in the Northeast 1991. NE/NA-INF-115-92. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station and Northeastern Area. 13.

(Report summarizes the results from 9 northeastern states (Maine, New Hampshire, Vermont, Massechusetts, Conneticut, Rhode Island, New Jersey, Maryland, and Delaware) from the 1991 Forest Health Monitoring field season.)

Attainment

Forest resource reports were published for Connecticut, Massachusetts, Ohio, Pennsylvania, and Rhode Island; which count for 30.3 million acres of forest land. In general, the results of these recent forest inventories are positive. Forest land is stable or increasing, stocking has improved, inventory volume continues to build, and growth-to-removal relationships remain favorable, suggesting continued expansion of inventory. Still, a trend towards maturation of large areas of forest has caused some health related problems to occur. Increased competition for sunlight and nutrients has caused a decrease in the number of small trees, making regeneration a concern for the future. The gypsy moth continues to ravage susceptable oak forests along the leading edge of its advance. This coupled with a strong demand for oak timber has caused declines in oak volume to show up for some regions.

Summaries of forest products output were reported for Delaware, Maryland, and New Jersey; and an overview of pulpwood production in northern states was published. These publications document improved utilization of roundwood harvested and record levels of pulpwood harvest. To address the need for improved availability of resource data, a comprehensive database containing consistant information for all states in the eastern United States, termed the Eastwide Database, was developed and documentation was published in a Station publication.

Problem 2 **Conducting special analyses of specific resource issues and concerns**
FY 93 Research Attainments

Publications

Research Unit

Birch, Thomas W.; Gansner, David A.; Arner, Stanford L.; Widmann, Richard H. 1992. Cutting activity on West Virginia timberlands. Northern Journal of Applied Forestry. 9 (4): 146-148.

Gansner, David A.; Arner, Stanford L.; Widmann, Richard H.; Alerich, Carol L. 1993. What's up with Penn's oak? National Woodlands. 16 (3): 8-10.

Gansner, David A.; Arner. Stanford L.; Widmann, Richard H.; Alerich, Carol L. 1993. What's up with Billy Penn's oak? The Allegheny News. 2 (3): 13-15.

Gansner, David A.; Drake, David A.; Arner, Stanford L.; Hershey, Rachel Riemann; King, Susan L. 1993. Defoliation potential of gypsy moth. NE-INF-117-93. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 4 p.

McWilliams, William H.; Birch, Thomas W. 1992. Who owns U.S. timber? National Woodlands. 15 (4): 16-18.

McWilliams, William H.; Hershey, Rachel Riemann; Drake, David A.; Alerich, Carol L. 1993. Characterizing forest composition of the Allegheny Mountains using extensive forest inventory data: an overview. In: Lund, H. Gyde, ed. Proceedings national workshop: Integrated ecological and resource inventories; 1993 April 12-16; Pheonix, AZ. WO-WSA-4. Washington, DC: U.S. Department of Agriculture, Forest Service: 113-115.

McWilliams, William H.; Mills, John R.; Burkman, William G. 1993. The state of the Nation's forest land. National Woodlands. 16 (2): 8-10, 13.

Widmann, Richard H.; Gansner, David A.; Arner, Stanford L.; Alerich, Carol L.; Quimby, John W. 1992. Impact of gypsy moth on oak in Pennsylvania District 7. In: Gottschalk, Kurt W.; Twery, Mark J., eds. Proceedings U.S. Department of Agriculture interagency gypsy moth research forum 1992; 1992 January 13-16; Annapolis, MD. Gen. Tech. Rep. NE-170. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 56. Abstract.

Cooperative

Brooks, Robert T.; Dickson, David R.; Burkman, William G.; Millers, Imants; Miller-Weeks, Margaret; Cooter, Ellen. 1992. Forest health monitoring in New England: 1990 annual report. Resour. Bull. NE-125. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 111 p.

Brooks, Robert T.; Frieswyk, Thomas S.; Griffith, Douglas M.; Cooter, Ellen; Smith, Luther. 1992. The New England forest: Baseline for New England forest health monitoring. Resour. Bull. NE-124. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 89 p.

Zipperer, Wayne C.; Birch, Thomas W. 1993. Forest-land ownership patterns. In: New York - New Jersey Highlands regional study: analysis of selected resources. NA-TP-04-93. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Area: 67-70.

Attainment

There is widespread concern about the health and productivity of our Nation's forests. Our FIA work unit is tackling this issue on several fronts. Hundreds of permanent plots have been established in the Northeast to monitor changes in tree condition, soil chemistry and other factors that reflect the health of the region's forests. A special analysis of Pennsylvania oak show that gypsy moth defoliation, drought, deer browsing, and other stresses have taken their toll; especially on the smaller size classes. Oak still accounts for more than one-fourth of the larger growing stock, proving that the Quaker State retains a viable oak resource.

A model which estimates the likelihood of gypsy moth defoliation was applied to recent forest inventory plot data to produce a susceptibility rating and maps showing current defoliation potential in a seven-state area where this pest is an immediate threat. Studies of owner attributes, attitudes, and actions indicate that the Northeast timber resource is ripe for more cutting and that landowners favor increased harvesting, at a time when recent government initiatives support a climate for timber development. A summary of the state of the Nation's forests explains how focusing on the impact of the spotted owl, forest health, and wetlands legislation has effected public policy on forest resources–biodiversity, recreation, water, wildlife, and timber. Results of this research have been presented to resource managers, policy makers, and other researchers through publications, workshops, and other appropriate outlets.

Northeastern Forest Experiment Station
Resource Analysis Research
Research Work Unit 4803

Analysis of Domestic and International Hardwood Product Markets
Luppold, William G., Project Leader

FY 93 Research Attainments
Research Work Unit Summary

Problem number and title	Functional account	Current funding	Current staffing	Research Outputs: Research unit	Research Outputs: Extra-mural	Research Outputs: Cooperative
		thousand dollars	*scientist years*			
1. Explain the interrelationships among domestic markets for hardwood products	RAR	530	2.9	13		3
2. Develop more detailed information on int'l. hardwood products trade and describe impact	RAR	503	2.0	12	2	4
3. Market-based decision making tools which can be used by hardwood processors and rural land owners	RAR	51	.1			3

Problem 1 **Explain the interrelationships among domestic markets for hardwood products**
FY 93 Research Attainments

Publications

Research Unit

Luppold, William G. 1993. Real world considerations in assessing market feasibility. In: Forest Products Society 47th annual meeting: biographies & abstracts; 1993 June 20-23; Clearwater Beach, FL. Madison, WI: Forest Products Society: 18. Abstract.

Luppold, William G. 1992. Factors influencing price and availability of hardwood pallet material. Pallet Enterprise. 12 (6): 2-3.

(Article published in the Lumber Source 1992 insert of Pallet Enterprise.)

Luppold, William G. 1993. A decade of change in the hardwood industry. [part 1]. Hardwood Market Report. 71 (27): 9-10.

Luppold, William G. 1993. A decade of change in the hardwood industry. [part 2]. Hardwood Market Report. 71 (28): 9-10.

Luppold, William G. 1993. A decade of change in the hardwood industry. [part 3]. Hardwood Market Report. 71 (29): 10-12.

Luppold, William G. 1993. A decade of change in the hardwood industry. [part 4]. Hardwood Market Report. 71 (30): 9-11.

Luppold, William G. 1993. Why are lumber prices so high? Will they remain high? Pallet Enterprise. 13 (3): 24, 26.

Luppold, William G.; Dempsey, Gilbert P. 1993. Analysis of eastern hardwood production shows regional shift. National Hardwood Magazine. 66 (13): 36, 40.

Nolley, Jean W. 1992. Bulletin of hardwood market statistics: spring 1992. Res. Note NE-350. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 43 p.

Nolley, Jean W. 1992. Bulletin of hardwood market statistics: summer 1992. Res. Note NE-351. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 43 p.

Nolley, Jean W. 1993. Bulletin of hardwood market statistics: fall 1992. Res. Note NE-352. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 43 p.

Nolley, Jean W. 1993. Bulletin of hardwood market statistics: winter 1992. Res. Note NE-353. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 43 p.

West, Cynthia D. 1993. The chip mill factor. In: Forest Products Society 47th annual meeting: biographies and abstracts; 1993 June 20-23; Clearwater Beach, Fl. Madison, WI: Forest Products Society: 19. Abstract.

Cooperative

Punches, John W.; Bush, Robert J.; Luppold, William G. 1993. Wood materials use in the U.S. cabinet industry: 1991 to 1993. In: Forest Products Society 47th annual meeting; biographies & abstracts; 1993 June 20-23; Clearwater Beach, Fl. Madison, WI: Forest Products Society: 55. Abstract.

Sinclair, Steven A.; Hansen, Bruce G. 1993. The relationship between purchase decisions and quality assessment of office furniture. Wood and Fiber Science. 25 (2): 142-152.

(Work performed under cooperative agreement with Virginia Polytechnic Institute and State University)

Sinclair, Steven A.; Hansen, Bruce G.; Fern Edward, F. 1993. Industrial forest product quality: an empirical test of Garvin's eight quality dimensions. Wood and Fiber Science. 25 (1): 66-76.

(Work performed under cooperative agreement with Virginia Polytechnic Institute and State University.)

Attainment

Domestic production and usage of hardwood lumber are affected by economic and meteorological conditions. In the mid-1980's, hardwood lumber production increased dramatically with much of this increase occurring in the North Central and Lake States Regions. This increase was due to increased domestic and international demand for higher grade red oak, white oak, and hard maple lumber. During the recession of 1991, hardwood lumber production declined as did hardwood lumber inventories held at the sawmill and secondary processing plants. When economic conditions improved in 1992 and 1993, hardwood lumber demand increased. Unfortunately, hardwood lumber production could not keep pace with this increased demand because several mills closed permanently during the 1991 recession; others had difficulty obtaining capital for log and equipment purchases and reduced log supplies due to continual wet weather. Because lumber inventories were depleted during the recession, hardwood lumber prices increased substantially. The greatest increases were in lower grade lumber which had traditionally been consumed by the pallet industry. Prices of low-grade hard and soft maple doubled from January 1992 to July 1993, while low-grade lumber prices of most other species increased by 50 to 85 percent. Although hardwood lumber prices are expected to moderate or go down in the next 12 months, the current high prices have affected the profitibility of most secondary hardwood product manufacturers.

Problem 2 **Develop more detailed information on int'l. hardwood products trade and describe impact**
FY 93 Research Attainments

Publications

Research Unit

Hansen, Bruce; Luppold, William. 1992. Factors affecting Japanese hardwood lumber imports, 1976 to 1990. Forest Products Journal. 42 (9): 47-51.

Hansen, Bruce G. 1992. A decade of European tropical and temperate hardwood product imports: 1981 to present. In: 46th annual meeting: biographies & abstracts; 1992 June 21-24; Charleston, SC. Madison, WI: Forest Products Society: 16. Abstract.

Hansen, Bruce G.; Luppold, William G. 1992. Japanese demand for hardwood lumber. In: 46th annual meeting: biographies & abstracts; 1992 June 21-24; Charleston, SC. Madison, WI: Forest Products Society: 58. Abstract.

Hansen, Bruce G.; Luppold, William G.; Smith, W. Ramsey. 1992. Overview of U.S. hardwood exports to Japan with emphasis on exchange rate influences in hardwood lumber imports [in Japanese]. Wood Report. 6 (13): 15-17.

(Journal published by the Japan Wood Products Information and Research Center.)

Luppold, W.G. 1992. Data considerations when analyzing changes in international demands for forest products. In: IUFRO proceedings: All-division 5 conference "forest products"; 1992 August 23-28; Nancy, France. [place of publication unknown]: [publisher name unknown]: 812. Abstract.

Luppold, William. 1992. The hardwood log export situation. In: Welker, John C.,comp. Proceedings, 1992 Southern Forest Economics Workshop on economics of southern forest productivity; 1992 April 29-May 1; Mobile, AL. Columbus, GA: Woodlands Mead Coated Board Co.: 43-53.

Luppold, William G. 1993. Causes and impacts of hardwood log exports. In: Forest Products Society 47th annual meeting: biographies & abstracts; 1993 June 20-23; Clearwater Beach, Fl. Madison, Wi: Forest Products Society: 19. Abstract.

Luppold, William G. 1992. The Canadian connection in the North American hardwood lumber export market. Northern Journal of Applied Forestry. 9 (3): 91-93.

West, Cynthia D. 1992. Global trade patterns for furniture products. In: FPRS 46th annual meeting: biographies & abstracts; 1992 June 21-24; Charleston, SC. Madison, WI: Forest Products Society: 62. Abstract.

West, Cynthia D. 1992. Competitive analysis of the global trade in hardwood chips. In: Welker, John C., comp. Proceedings, 1992 Southern Forest Economics Workshop on economics of southern forest productivity; 1992 April 29-May 1; Mobile, AL. Columbus, GA: Woodlands Mead Coated Board Co.: 27-41.

West, Cynthia D. 1993. Exports of basic timber resources: who wins and who loses. In: Proceedings: Agriculture's changing horizon, 69th annual outlook conference; 1992 December 1-3; Washington, DC. Washington, DC: U.S. Department of Agriculture: 254-262.

West, Cynthia D.; Sinclair, Steven A. 1992. A measure of innovativeness for a sample of firms in the wood household furniture industry. Forest Science. 38 (3): 509-524.

(Work performed under a cooperative agreement with Virginia Polytechnic Institute and State University.)

Cooperative

Armstrong, James P.; Ponzurick, Thomas G.; Luppold, William G. 1993. Criteria affecting purchases of U.S. hardwood lumber by various Canadian market segments. In: Forest Products Society 47th annual meeting: biographies & abstracts; 1993 June 20-23; Clearwater Beach, FL. Madison, WI: Forest Products Society: 54. Abstract.

Armstrong, James P.; Ponzurick, Thomas G.; Luppold, William G. 1993. Marketing-related criteria affecting the purchase of U.S. hardwood lumber by Canadian importers. Forest Products Journal. 43 (6): 57-62.

(Work performed under cooperative agreement with West Virginia University.)

Armstrong, James P.; Ponzurick, Thomas G.; Luppold, William G. 1993. U.S. hardwood lumber exports to Canada: an assessment of market segments. Forest Products Journal. 43 (6): 13-18.

(Work performed under cooperative agreement with West Virginia University.)

Smith, Paul M.; West, Cynthia D. 1992. A strategic framework for globally-oriented wooded furniture manufacturers: an emphasis on South Korea. In: Youn, Yeo Chang; Schreuder, Gerard F., eds. International trade in forest products around the Pacific Rim; 1991 October 8-11; Seoul, Korea. Suwon, Republic of Korea: Seoul National University, College of Agriculture and Life Sciences: 99-121.

(Work performed under cooperative agreement with the Pennsylvania State University.)

Extramural

Hammett, A.L., III; DeForest, Christopher E. 1992. Keys to export success: attributes of southern hardwood exporters. In: Welker, John C., comp. Proceedings, 1992 Southern Forest Economics Workshop on economics of southern forest productivity; 1992 April 29-May 1; Mobile, AL. Columbus, GA: Woodlands Mead Coated Board Co.: 55-69.

(Work performed under cooperative agreement with the University of Georgia.)

Hammett, A.L., III; DeForest, Christopher E. 1993. Southern hardwood lumber exporters: practices and problems. Forest Products Journal. 43 (3): 9-14.

(Work performed under cooperative agreement with the University of Georgia.)

Attainment

Canada, Asia, and Europe continue to be important markets for domestic hardwood product manufacturers. Canada has traditionally been the largest international market for U.S. hardwood. Red and white oak account for nearly half of the lumber exported to Canada. Canadian customers tend to purchase a large proportion of higher grade (FAS and 1F) lumber, but the Canadian flooring industry consumes large quantities of lower grade and ungraded lumber.

Canadian lumber customers are especially concerned with grading accuracy, lumber straightness, general cleanliness, and moisture content accuracy. These customers are least concerned with packaging activities such as wrapping and trademarking. Japan is the largest export market of the U.S. hardwood products on a value basis. Japanese demand increased in the early and mid 1980's because of declining value of the dollar against the Yen, the reduced supplies of tropical material, and the reduced production of temperate lumber within Japan. Exports to Japan stabilized and then decreased slightly during the late 1980's as the dollar stabilized against the Yen and alternative supplies of temperate material were found in China and Russia. One of the most divisive issues concerning hardwood exports is the export of raw hardwood logs and chips. Although raw material exports are small relative to total U.S. production, log exports to Europe and Asia have increased the cost of veneer logs while chip exports have been concentrated in specific regions.

Problem 3 **Market-based decision making tools which can be used by hardwood processors and rural land owners**
FY 93 Research Attainments

Publications

Cooperative

Mendoza, G.A.; Meimbam, R.J.; Luppold, W.G.; Araman, P.A. 1992. Combining simulation and optimization models for hardwood lumber production. In: Pacific Rim forestry- bridging the world: Proceedings of the Society of American Foresters national convention; 1991 August 4-7; San Francisco, CA. SAF Publ. 91-05. Bethesda, MD: Society of American Foresters: 356-361.

(Work performed under cooperative agreement with the University of Illinois and in cooperation with RWU-SE-4702 located at Blacksburg, VA.)

Mendoza, Guillermo A.; Meimban, Roger J.; Araman, Philip A.; Luppold, William G. 1992. Combined log inventory and process simulation models for the planning and control of sawmill operations. In: Proceedings: 23rd CIRP international seminar on manufacturing systems; 1991 June 6-7; Nancy, France. [Place of publ. unknown]: [Publisher name unknown]: 8 p.

(Work performed under cooperative agreement with the University of Illinois and in cooperation with RWU-SE-4702 located at Blacksburg, VA.)

Steele, Philip H.; Luppold, William; Araman, Philip A.; Jackson, David J. 1993 Hardwood sawmill band versus circular headrig benefits and costs. In: Forest Products Society 47th annual meeting: biographies & abstracts; 1993 June 20-23; Clearwater Beach, FL. Madison, WI: Forest Products Society: 23. Abstract.

(Work performed under cooperative agreement with the Mississippi State University.)

Attainment

Primary hardwood lumber processors are facing increased raw material costs, increased substitution from alternative products, and continually changing markets for their products. Logs remain the most costly input in hardwood lumber production. Log inventory costs can be significant but not having sufficient logs of specific quality and species mix reduces sales and profitability. Because of this situation, a log inventory model was developed to monitor and periodically update the status of logs in the log yard. This model takes into account the different static and dynamic features of individual sawmills.

In order to survive in a changing market, primary processors must become increasingly efficient in their manufacturing process. Simulation models have been developed and used to emulate the general operation and performance of sawmills but do not optimize. Optimization models are used to develop the optimal production plan with minimal concern for real-time, day-to-day operation of sawmills. By combining simulation and optimization models, a procedure is developed that considers both the determination and implementation of optimal sawmill production schedules.

Northeastern Forest Experiment Station
Resource Analysis Research
Research Work Unit 4804

Economic Potential of Forest Production in the North
Sendak, Paul E., Project Leader

FY 93 Research Attainments
Research Work Unit Summary

Problem number and title	Functional account	Current funding	Current staffing	Research Outputs: Research unit	Research Outputs: Extra-mural	Research Outputs: Cooperative
		thousand dollars	*scientist years*			
1. Lack of understanding of reasons for underutilization of timber resource in the North	RAR	339	2.7	4	2	
2. The implementation of ATLAS for the North will require extensive research on forest inventory	RAR	30	.3			

Problem 1 **Lack of understanding of reasons for underutilization of timber resource in the North**
FY 93 Research Attainments

Publications

Research Unit

Dennis, Donald F. 1993. An empirical study of posting private nonindustrial forests. Wildlife Society Bulletin. 21 (1): 6-10.

Dennis, Donald F.; Sendak, Paul E. 1993. Analyzing the effectiveness of Vermont's modified assessment program for forest land. In: Schmithusen, Franz, ed. Forestry legislation–report of the IUFRO Subject Group S6.13-00 "Forest law and environmental legislation"; 1990 August 8; Montreal, PQ. Zurich, Switzerland: International Union of Forestry Research Organizations: 55-61.

(The report was prepared at the occasion of the IUFRO Centennial Meeting in Berlin/Eberswald in September 1992 and includes the contributions which have been presented by the members of the Subject Group as voluntary papers to the congress.)

Dennis, Donald F.; Sendak, Paul E. 1993. Use-value appraisal for Vermont forest land. The Consultant. 38 (2): 28-29.

Huyler, Niel K.; Turner, Terry L. 1993. Quality wood from underutilized trees. Northern Journal of Applied Forestry. 10 (2): 95-97.

Extramural

Powers, Eileen; Newton, Carlton M. 1993. Transportation network for uneven-aged forest management. In: Proceedings of the 13th annual environmental systems research institute user conference; 1993 May 23-27; Palm Springs, CA. Redlands, CA: Environmental Systems Research Institute: 1-15.

Powers, Eileen A. 1993. Transportation network modeling for uneven-aged forest management. Burlington, VT: The University of Vermont. 57 p. M.S. thesis.

(Work unit provided funding for the research and discussed ideas for research direction.)

Attainment

The following reflects major accomplishments for the life of this problem. Almost 1/2 of the Nation's hardwoods are contained in the Northeast and Northcentral regions. Most of this timber grows on privately-owned lands where growth exceeds removals by almost 2 to 1. Any solution to increased utilization of the forest resources in the North needs to address timber production on private lands. This problem was addressed through timber supply research, assessing private landowner behavior; timber stumpage price research; assessment of log production alternatives; research on institutional factors; and research on how private landowners make resource management decisions. Research results on landowner behavior highlight the influence of forest characteristics and landowner affluence on the timber harvest decision. Timber stumpage prices determine the profitibility of a forestry operation. Results have shown that forest growth and increasing stumpage prices combined have proved lucrative to private landowners. However, marketing and utilization of small, low-quality hardwood trees are still problems for the land manager. Analyses of use-value property taxation have shown that the program lowers the cost of holding forestland, allowing land to remain in forestry and motivates otherwise uninterested owners to manage their woodlands. The accomplishments help to explain the reasons for underutilization of the timber resource and suggest strategies for increased utilization. Results of this research have been communicated through publications and meetings.

Problem 2 **The implementation of ATLAS for the North will require extensive research on forest inventory**
FY 93 Research Attainments

Publications

none

Attainment

The following reflects major accomplishments for the life of this problem. To date, the project has investigated the methods used to develop growth inputs for the ATLAS modeling process and evaluated an alternative method. Attention was focused on two timber types that encompass a large proportion of existing volume and management effort – maple/beech/birch (MBB) and spruce/fir (SF). MBB is usually managed in two-age or multi-age stands and SF most often as even-age stands. In the ATLAS management-unit module, two growth related inputs are critical: A growth/yield guide curve and stocking density change parameters. The guide curve provides base yield-table volumes per acre by age class. Individual inventory cells of a certain age class are "grown" into the next age class by multiplying the appropriate yield table value by the stocking ratio, adjusted by the stocking density change equation. Serious flaws were found in the Northeast Region RPA data base. An alternative to the RPA data base was found in the Forest Inventory and Analysis (FIA) data for individual states. Tree-level records on remeasured, fixed radius plots for the states of Maine, New Hampshire, Vermont, and New York were used. Overall, the FIA data required substantial effort to acquire and interpret. However, the FIA data did allow estimation of satisfactory growth/yield guide curves and stocking density change parameters for the MBB and SF type groups using a process parallel to that used in the RPA projections. The insight gained to date will be used in the final phase of the project to evaluate the sensitivity of the ATLAS projections to variability in growth parameters and to evaluate the partial-cutting option, specifically for MBB. Results and recommendations will be communicated to RPA and the Northern Global Climate Change Research Program and through publications and meetings.

Northeastern Forest Experiment Station
Resource Analysis Research
Research Work Unit 4951

Forest Recreation Investment Research
Echelberger, Herbert E., Project Leader

FY 93 Research Attainments
Research Work Unit Summary

Problem number and title	Functional account	Current funding	Current staffing	Research Outputs		
				Research unit	Extra-mural	Cooper-ative
		thousand dollars	*scientist years*			
1. Inadequate knowledge of costs of investments in provision of forest recreation opportunities	RAR	0	.0	1		
2. Inadequate knowledge of factors affecting perceived quality of recreation opportunities	RAR	182	2.0	4		2
3. Recreation oprtnty. investments made w/inadequate understanding of costs/perceived quality	RAR	189	2.0	2	2	1

Problem 1 **Inadequate knowledge of costs of investments in provision of forest recreation opportunities**
FY 93 Research Attainments

Publications

Research Unit

Echelberger, Herbert E.; Bennink, John P.; Moulton, George W. 1992. Tourism research and protection of the Conneticut River Valley. New England Journal of Travel and Tourism. 3: 3-8.

Attainment

The following reflects major accomplishments for the life of this problem. Since the initiation of this RWUD, many studies have been reported that shed light on the costs involved with providing forest recreation opportunities. Among them are: "Anatomy of backcountry management costs" in NEFES Res. Pap. NE-575; "Trends in the cost of providing public outdoor recreational opportunities" and "Nascent trends in the private campground industry" both published in Proceedings 1985 National Outdoor Recreation Trends Symposium; "Costs and revenues in Delaware state parks with implications for management strageties" presented to the NRPA Symposium on Leisure Research in 1984; "Tracking the economic health of the cross country ski industry: 1984-1988" published in the Proceedings of the 1990 Outdoor Recreation Trends Symposium III; "Cross country skiing's contribution to enhanced rural living" in Proceedings of Enhanced Rural Economics Through Amenity Resources, published in 1990.

Other, less pertinent contributions are: "A case study of Lake Champlain fishing access sites in Vermont" presented to the 4th North American Symposium on Society and Resource Management in 1992; "Tourism research and protection of the Conneticut River Valley" published in the New England Journal of Travel and Tourism 1n 1992, and "Lake Champlain Recreation Management Program: results from the recreation resources inventory, boat study and recreation user surveys" presented at the Northeastern Recreation Researchers Symposium in 1993.

Problem 2 **Inadequate knowledge of factors affecting perceived quality of recreation opportunities**
FY 93 Research Attainments

Publications

Research Unit

Glass, Ronald J.; More, Thomas A.; DiStefano, James J. 1993. The motives and operational characteristics of Vermont trappers. In: Witaker Hoagland, Julianne, ed. Proceedings of the 11th Midwest and 7th Southeastern furbearer workshop; 1993 April 12-16; Wagoner, OK. Oklahoma City, OK: Oklahoma Department of Wildlife Conservation: 18. Abstract.

Glass, Ronald J.; More, Thomas A. 1992. Satisfaction, valuation, and views toward allocation of Vermont goose hunting opportunities. Res. Pap. NE-668. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 5 p.

Glass, Ronald J.; More,Thomas A.; Gilbert, Alphonse H. 1993. Eastern wilderness: extramarket values and public preference for management. In: Vander Stoep, Gail A., ed. Proceedings of the 1992 Northeastern recreation research symposium; 1992 April 5-7; Saratoga Springs, NY. Gen. Tech. Rep. NE-176. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station: 131-135.

More, Thomas A.; Averill, James R. 1992. Satisfaction, happiness, and emotion in the recreation experience: are we asking the right questions? In: Chavez, Deborah J., tech. coord. Proceedings of the symposium on social aspects and recreation research: Summary of round table session; 1992 February 19-22; Ontario, CA. Gen. Tech. Rep. PSW-GTR-132. Berkeley, CA: U.S. Department of Agriculture, Forest Service. Pacific Southwest Forest and Range Experiment Station: 84 p.

Cooperative

Averill, James R.; More, Thomas A. 1993. Happiness. In: Lewis, Michael; Haviland, Jeannette M., comps., eds. Handbook of emotions. New York, NY: The Guilford Press: 617-629.

Gilbert, A.; Glass, R.; More, T. 1992. Valuation of Eastern wilderness: extramarket measures of public support. In: Payne, Claire; Bowker, J.M.; Reed, Patrick C., comps. The economic value of wilderness: Proceedings of the conference; 1991 May 8-11; Jackson, WY. Gen. Tech. Rep. SE-78. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southeastern Forest Experiment Station: 57-70.

Attainment

The following reflects major accomplishments for the life of this problem. The quality of visitor experiences is a major concern of recreation resource management. Unit research on this highly important topic has provided significant advances at both the applied and conceptual levels. At the applied level, recent research has sought to understand factors that motivate participation in such diverse resource-based recreation activitites as goose hunting, trapping, and visiting eastern wilderness areas. Such motivational factors also influence what participants are willing to pay for a particular recreation opportunity and the distribution of benefits stemming from a particular site or opportunity. At the conceptual level, unit scientists have formulated a new theory of recreation quality based upon understanding the psychological components of the recreation experience. The theory integrates the emotional and cognitive dimensions of experience into a framework of biological, psychological, and social factor. It helps explain why particular site attributes identified in applied studies are important, and suggests new interpretations that have been overlooked. This appears to be an enormously fruitful area for future research leading to new management prescriptions and insights. Over the lifespan of this problem unit research has greatly enhanced understanding of recreation quality in such diverse activities and resources as forest campgrounds, beaches, urban parks, hunting and fishing, and nonconsumptive wildlife recreation, and state/regional parks.

Problem 3 **Recreation oprtnty. investments made w/inadequate understanding of costs/perceived quality**
FY 93 Research Attainments

Publications

Research Unit

Glass, Ronald J.; More, Thomas A.; Zwick, Rod. 1993. Contribution of fish and wildlife to the level of living of rural New England households. In: 49th annual Northeast fish and wildlife conference abstracts; 1993 April 18-21; Atlantic City, NJ. Trenton, NJ: The New Jersey Department of Environmental Protection and Energy, Division of Fish, Game and Wildlife: 134. Abstract.

Glass, Ronald J.; Muth, Robert M. 1992. Commodity benefits from wilderness: Salmon in Southeast Alaska. In: Payne, Claire; Bowker, J.M.; Reed, Patrick C., comps. The economic value of wilderness: Proceedings of the conference; 1991 May 8-11; Jackson, WY. Gen. Tech. Rep. SE-78. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southeastern Forest Experiment Station: 141-153.

Cooperative

Stevens, Thomas H.; More, Thomas A.; Glass, Ronald J. 1993. Measuring the existence value of wildlife: reply. Land Economics. 69 (3): 309-312.

Extramural

Halstead, John M.; Luloff, A.E.; Stevens, Thomas H. 1992. Protest bidders in contingent valuation. Northeastern Journal of Agricultural and Resource Economics. 21 (2): 160-169.

(Paper was partially based on research results from cooperatively funded studies.)

Stevens, T.H. 1992. The economic value of coyotes in New England. Resources and Environment: Management Choices–September. Amherst, MA: University of Massachusetts Cooperative Extension System. 3 p.

(Paper based upon research results from a cooperatively funded study.)

Attainment

The following reflects major accomplishments for the life of this problem. Considerable progress was made toward the problem. Research demonstrated that a better understanding of the conceptual foundation, measurement, and interpretation of public-oriented values was needed. Several publications were devoted to this end, while others pursued more traditional cost-return interrelationships. The extent of publicly-owned and -operated wildlife management areas was examined for New York and New England as well as the opportunities they provide the public and the costs of operation. Public preferences and expectations for services rendered by state historic sites were examined. Costs and returns, including those not traditionally included in conventional economic analysis, were examined and considered in their relationship to broader expressions of public-oriented wants and values. Conceptual inadequacies in traditional economic analysis were scrutinized and alternative measurement schemes suggested. The subsistance lifestyle was examined to gain a better understanding of broad-based values and resource dependency.

Northeastern Forest Experiment Station
Resource Analysis Research
Research Work Unit 4952

Structure and Function of Urban Forests
Rowntree, Rowan A., Project Leader

FY 93 Research Attainments
Research Work Unit Summary

Problem number and title	Functional account	Current funding	Current staffing	Research Outputs		
				Research unit	Extra-mural	Cooper-ative
		thousand dollars	*scientist years*			
1. Structure and function of urban forest systems	RAR	1348	7.0	25	2	11

Problem 1 **Structure and function of urban forest systems**
FY 93 Research Attainments

Publications

Research Unit

Andersen, Carol G.; Zipperer, Wayne C. 1993. Analysis of residential development and effects on natural area management. In: Conference abstracts: papers and posters: 20th annual natural areas conference; 1993 June 22-26; Orono, ME. [Place of publication unknown]: Natural Areas Association: 86. Abstract.

Cinquemani Kuehn, D.; Leopold, Donald J. 1992. Long-term demography of Phyllitis scolopendrium (L.) Newm. var. americana fern in central New York. Bulletin of the Torrey Botanical Club. 119 (1): 65-76.

(Research conducted by a Cooperative Education Student, Cinquemani Kuehn, 1987-1989.)

McPherson, E. Gregory. 1992. Benefits and costs of planned tree plantings in twelve U.S. cities. Journal of Aboriculture. 18(6): 330. Abstract.

McPherson, E. Gregory. 1992. Accounting for benefits and costs of urban greenspace. Landscape and Urban Planning. 22: 41-51.

McPherson, E. Gregory. 1992. Shading and urban heat islands in U.S. desert cities. Sonderdruckaus Wetter Und Leben. 44: 107-123.

McPherson, E. Gregory; Nowak, David J.; Sacamano, Paul L.; Prichard, Scott E.; Makra, Edith M. 1993. Chicago's evolving urban forest: initial report of the Chicago Urban Forest Climate Project. Gen. Tech. Rep. NE-169. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 55 p.

McPherson, E. Gregory; Simpson, James R.; Sacamano, Paul L. 1993. Impact of urban heat island cooling and environment: a demonstration project. Southwest Horticulture. 10 (2): 20.

McPherson, Greg. 1992. Environmental benefits and costs of the urban forest: two examples from Tucson, Arizona. In: McCulloch, J., ed. Proceedings of international conference on cities and global change; Toronto, ON. Washington, DC: The Climate Institute: 218-224.

McPherson, Greg. 1992. Putting research to work. Urban Forests. 12 (5): 5.

Nowak, D.J. 1993. Remote sensing and urban forestry. In: American forestry–an evolving tradition: Proceedings of the 1992 Society of American Foresters national convention; 1992 October 25-28; Richmond, VA. SAF Publ. 92-01. Bethesda, MD: Society of American Foresters: 103-108.

Nowak, D.J.; McPherson, E.G. 1993. Quantifying the impact of trees: the Chicago Urban Forest Climate Project. Unasylva (173). 44 (2): 39-44.

Nowak, David J. 1992. The evolution of Oakland's urban forest. Journal of Arboriculture. 18(6): 329. Abstract.

(Presentation abstract.)

Nowak, David J. 1993. Atmospheric carbon reduction by urban trees. Journal of Environmental Management. 37 (3): 201-217.

Nowak, David J. 1993. Compensatory value of an urban forest: an application of the tree-value formula. Journal of Arboriculture. 19 (3): 173-177.

Nowak, David J.; McBride, Joe R. 1993. Testing microdensitometric ability to determine Monterey pine urban tree stress. Photogrammetric Engineering and Remote Sensing. 59 (1): 89-91.

Nowak, David J.; Sisinni, Susan. 1993. Plant chemical emissions. Miniature Roseworld. 10 (1): 4-6.

Nowak, David J.; Sydnor, T. Davis. 1992. Popularity of tree species and cultivars in the United States. Gen. Tech. Rep. NE-166. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 44 p.

Pouyat, R.V. 1993. Carbon and nitrogen dynamics in oak stands along an urban-rural land use gradient. In: Abstract: 8th North American forest soils conference; 1993 May 9-13; Gainesville, FL. [Place of publication unknown]: [Publisher name unknown]: 30. Abstract.

Simpson, J.R.; Sacamano, P.L.; McPherson, E.G. 1993. Impact of urban heat island on cooling and environment: a demonstration project. Washington, DC: Public Technology, Inc. 101 p.

Sisinni, Susan M.; Emmerich, Anthony. 1992. Methodologies, results and applications of natural resource assessments in New York City, New York. In: Hedge, Cloyce, ed. Proceedings 19th annual natural areas conference; 1992 October 27-30; Bloomington, IN. Bloomington, IN: Indiana University: 53. Abstract.

Zipperer, Wayne C. 1992. Population growth and forest loss analysis. In: New York-New Jersey Highlands regional study. Washington, DC: U.S. Department of Agriculture; 38-43.

Zipperer, Wayne C.; Birch, Thomas W. 1992. Forest land ownership. In: New York-New Jersey Highlands regional study. Washington, DC: U.S. Department of Agriculture; 34-37.

Zipperer, Wayne C. 1993. Analysis of population growth and forest loss. In: New York - New Jersey Highlands regional study: analysis of selected resources. NA-TP-04-93. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Area: 71-78.

Zipperer, Wayne C.; Birch, Thomas W. 1993. Forest-land ownership patterns. In: New York-New Jersey Highlands regional study: analysis of selected resources. NA-TP-04-93. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Area: 67-70.

Zipperer, Wayne C.; Zipperer, Constance E. 1992. Vegetation responses to changes in design and management of an urban park. Landscape and Urban Planning. 22: 1-10.

Cooperative

Carreiro, M.M.; Pouyat, R.V. 1993. Variation in oak leaf litter quality and its role in decomposition along an urban-rural environmental gradient. Bulletin of the Ecological Society of America. 74(2) (Suppl.): 187. Abstract.

(Poster abstract.)

Dawson, Chad P.; Zipperer, Wayne C. 1992. Impacts of land use changes on recreation and open space in the New York-New Jersey Highlands region. In: Chavez, D., Tech. Coord. Symposium on social aspects and recreation research; 1992 February 19-22; Ontario, CA. Gen. Tech. Rep. PSW-GTR-132. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station: 67-68.

Dwyer, John F.; McPherson, E. Gregory; Schroder, Herbert W.; Rowntree, Rowan A. 1992. Assessing the benefits and costs of the urban forest. Journal of Arboriculture. 18 (5): 227-234.

Goldman, Meadow B.; Groffman, Peter M.; Pouyat, Richard V.; McDonnell, Mark M.; Pickett, Steward T.A. 1993 Methane consumption and nitrogen availability in forest soils along an urban to rural gradient. Bulletin of the Ecological Society of America. 74(2) (Suppl.): 252. Abstract.

Groffman, Peter M.; Pouyat, Richard V.; McDonnell, Mark M.; Pickett, Steward, T.A.; Zipperer, Wayne C. 1993. Carbon and nitrogen cycling in urban forests. In: Abstracts: international symposium soil processes and management systems, greenhouse gass emissions and carbon sequestration; 1993 April 5-9; Columbus, OH. [Place of publication unknown]: [Publisher name unknown]. Abstract.

McDonnell, Mark J.; Pickett, Steward T.A.; Pouyat, Richard V. 1993. The application of the ecological gradient paradigm to the study of urban effects. In: McDonnell, M.J.; Pickett, T.A., comps., eds. Humans as components of ecosystems: subtle human effects and the ecology of populated areas. New York, NY: Springer Verlag: 175-189.

Neville, L. Robert; Zipperer, Wayne C.,tech coords. 1993. New York-New Jersey Highlands regional study: analysis of selected resources. NA-TP-04-93. Radnor, PA: U.S. Department of Agriculture, Forest Service, Northeastern Area. 87 p.

Profous, G.; Rowntree, R. 1993. Structure and management of the urban forest in Prague. Unasylva (173). 44 (2): 33-38.

Profous, George V.; Rowntree, Rowan A. 1993. The structure and management of the urban forest in Prague, Czechoslovakia. I. Growing space in metropolitan Prague. Arboricultural Journal. 17 (1): 1-31.

Profous, George V.; Rowntree, Rowan A. 1993. The structure and management of the urban forest in Prague, Czechoslovakia. II. History of Prague greenspace management. Aboricultural Journal. 17 (2): 117-130.

Wang, Y.S.; Miller, D.R.; Welles, J.M.; Heisler, G.M. 1992. Spatial variability of canopy foliage in an oak forest estimated with fisheye sensors. Forest Science. 38 (4): 854-865.

Extramural

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(Presentation abstract with no proceedings.)

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Attainment

The following reflects major accomplishments for the life of this problem. Studies of 47 U.S. urban forests show predictable variations in the main attribute of structure – above-ground phytomass, measured from % canopy cover – as a result of the spatial distribution of land use, and a set of historical, socioeconomic and ecological factors. A second attribute, species composition, shows that most cities' forests are dominated by several species but augmented by 100-200 species at lower frequencies. Urban forest structure is greatly influenced by local environment, city land use distribution, human preferences, and vegetation management. Structure determines an urban forest's range of functions which are translated into benefits and costs. Increasing diversity increases yearly costs but reduces costs from epidemic diseases. Locating trees in appropriate spots near homes reduces space heating and cooling costs up to 40% depending on climate and house type. Carbon dioxide is sequestered in significant amounts by urban phytomass. By reducing energy consumption, power plants emit less carbon dioxide with reduced generation requirements. Thus, urban forests contribute to regional and global air quality and climatic benefits. At the same time there are planting, maintenance, removal, and liability costs associated with urban trees. Concepts and methods have been developed to estimate the temporal distribution of various costs and benefits over the life spans of large sets of trees within the urban forest. Urban forests grade into adjacent "wildland" forests or other landscape mosaics. Studies describe forest and landscape fragmentation resulting from urbanization and the range of direct and indirect functional impacts on nearby ecosystems. Work also describes gradual and episodic changes that occur in urban forest ecosystems over time.

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